PB83-125989

Frequency Analysis of Pesticide Concentrations for Risk Assessment (FRANCO Model)

Battelle Pacific Northwest Labs.
Richland, WA

Prepared for

Environmental Research Lab.
Athens, GA

Aug 82

U.S. Department of Commerce
National Technical Information Service
NTIS

United States
Environmental Protection
Agency

Environmental Research
Laboratory
Athens GA 30613

EPA-600/3-82-044
August 1982

Research and Development

EPA

Frequency Analysis of Pesticide Concentrations for Risk Assessment (Franco Model)

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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/3-82-044	2. Applications Guide	3. RECIPIENT'S ACCESSION NO. PB83 125989
4. TITLE AND SUBTITLE Frequency Analysis of Pesticide Concentrations for Risk Assessment (FRANCO Model)		5. REPORT DATE August 1982
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) A.R. Olsen and S.E. Wise		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Battelle Pacific Northwest Laboratories Richland, Washington 99352		10. PROGRAM ELEMENT NO. AARB1A
		11. CONTRACT/GRANT NO. 68-03-2613
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Research Laboratory--Athens GA Office of Research and Development U.S. Environmental Protection Agency Athens, Georgia 30613		13. TYPE OF REPORT AND PERIOD COVERED Final, 4/78-1/80
		14. SPONSORING AGENCY CODE EPA/600/01
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

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17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 123
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE

EPA Form 2220-1 (9-73)

EPA-600/3-82-044
August 1982

FREQUENCY ANALYSIS OF PESTICIDE CONCENTRATIONS FOR RISK ASSESSMENT (FRANCO MODEL)

by

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Contract No. 68-03-2613

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ATHENS, GEORGIA 30613

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FOREWORD

As environmental controls become more costly to implement and the penalties of judgment errors become more severe, environmental quality management requires more efficient management tools based on greater knowledge of the environmental phenomena to be managed. As part of this Laboratory's research on the occurrence, movement, transformation, impact, and control of environmental contaminants, the Technology Development and Applications Branch develops management and engineering tools to help pollution control officials achieve water quality goals through watershed management.

Many toxic contaminants are persistent and undergo complex interactions in the environment. As an aid to environmental decision-makers, the Chemical Migration and Risk Assessment Methodology was developed to predict the occurrence and duration of pesticide concentrations in surface waters receiving runoff from agricultural lands and to assess potential acute and chronic damages to aquatic biota.

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ABSTRACT

This report describes a method for statistically characterizing the occurrence and duration of pesticide concentrations in surface waters receiving runoff from agricultural lands. The characterization bridges the gap between simulated instream pesticide modeling and the risk assessment information available from laboratory studies on aquatic biota. A computer program FRANCO is given to complete the frequency analysis of concentration characterization. The documentation is part of the Chemical Migration and Risk Assessment Methodology.

Companion reports to this document are Methodology for Overland and Instream Migration and Risk Assessment of Pesticides, User's Manual for the Instream Sediment-Contaminant Transport Model SERATRA, User's Manual for EXPLORE-I: A River Basin Water Quality Model (Hydrodynamic Module Only), and Mathematical Model SERATRA for Sediment-Contaminant Transport in Rivers and Its Application to Pesticide Transport in Four Mile and Wolf Creeks in Iowa.

This report was submitted in partial fulfillment of Contract No. 68-03-2613 by Battelle Pacific Northwest Laboratories under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period April 1978 to January 1980, and work was completed as of January 1980.

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ACKNOWLEDGMENTS

We wish to acknowledge several people at Battelle, Pacific Northwest Laboratories who significantly contributed to the development of the concepts, and their implementation, for the statistical frequency analysis of pesticides. Yasuo Onishi, Stuart M. Brown and Mary Ann Parkhurst adequately described the information available as input to the analysis and defined the toxicity information form. Without their help this program could never have been designed. In the early stages of development, Jim Johnston's painstaking attention to details and their implications was invaluable. The assistance of Sharon Popp, Barbara Roberts and Mary Heid in preparing this manuscript is greatly appreciated.

SECTION 1

INTRODUCTION

In order to provide planners and decision makers in government and industry with a sound basis for their decision making, a methodology is needed to predict the occurrence and duration of pesticide concentrations in surface waters receiving runoff from agricultural lands and to assess the potential acute and chronic damages to aquatic biota. Such a methodology has been developed by Battelle, Pacific Northwest Laboratories (1). The methodology consists of: 1) overland pesticide modeling, 2) instream pesticide modeling, 3) statistical analysis of instream pesticide modeling results, and 4) risk assessment procedure. This document describes the methods and computer program used in the statistical analysis of the pesticide concentrations

The statistical analysis was designed to bridge the gap between the results of the instream pesticide modeling and the risk assessment information available from laboratory studies on aquatic biota. The instream pesticide model used in the methodology, SERATRA, provides detailed pesticide concentration data over the simulated time period. For example, the pesticide concentration is given for each half-hour for 3 years in the case study used. A summary of this simulated pesticide time series is necessary if it is to be useful in a risk assessment. The pesticide concentration time series defines the information available for the assessment. The particular summary selected is based on the toxicity information available from laboratory studies. Results of acute bioassays and toxicity testing are reported as the median lethal concentration (LC50) for selected time periods, usually 24, 48 and 96 hours. Chronic toxicity is usually recorded as the amount of toxicant causing measurable effects. The maximum acceptable toxicant concentration (MATC) is one way to describe the effect-no effect boundary for chronic toxicity. The methods embodied in the Frequency of Analysis Concentration (FRANCO) computer program provide the link between the data available from SERATRA and the available toxicity information.

The concepts underlying the procedures used by FRANCO are explained in Section 2. This theoretical discussion is followed by a hypothetical example in Section 3. Section 4 briefly describes an example from the case study and illustrates the computer output available from FRANCO. Appendix A contains a user's manual for running FRANCO. Appendix B describes the functions of each of the modules in FRANCO and gives their interrelationships. Appendix C contains the computer program source listing for FRANCO.

SECTION 2

FREQUENCY ANALYSIS OF CONCENTRATION CONCEPTS

Statistically summarizing the simulated pesticide concentrations requires a precise interpretation of the phrase "frequency of occurrence and duration of pesticide concentrations." The risk assessment methodology provides information on pesticide concentrations that will result in an effect if the concentration remains at or above a specified level for a certain length of time. This concept forms the basis for the statistical summary. The summary of the simulated concentrations uses specific definitions for these terms: event and duration of an event. An event defined by a concentration of C occurs when a sequence of simulated concentrations begins below C at time step t_1, becomes and remains greater than or equal to C in subsequent time steps and then drops below C after time step t_2 (see Figure 1 where C is C_5). This is referred to as an event defined by concentration C. The duration of an event defined by concentration C is the length of time from the beginning to the end of the event, e.g., $t_2 - t_1$.

Utilizing the preceding concept of an event FRANCO provides three types of summaries: counts of time steps, counts of events and LC-function global exceedance. The latter is defined subsequently. Let $C_1<C_2<\ldots<C_m$ be a set of concentration levels used to define events. These are based on lethal concentration information from the risk assessment procedure and the concentration range expected from the SERATRA simulation. Let $d_1<d_2<\ldots<d_n$ be a set of durations selected on the same basis as the concentrations. All of the statistical summaries are completed for events defined by concentrations C_i $(i=1,\ldots,m)$ with durations of d_j $(j=1,\ldots,n)$ or greater. Each of the m concentration levels selected conceptually horizontally slices the SERATRA concentration time history plot. A number of concentration peaks occur above the horizontal line. FRANCO counts the time above the line and computes summary statistics based on these counts. Additional detail is provided by completing the above only for events of duration d_j or greater.

The first summary is a count of the number of events defined by concentration C_i with a duration of d_j or greater. This is denoted as $NE(C_i,d_j)$. Events defined by concentration C_i of any duration, i.e., greater than or equal to one time step, are denoted by $NE(C \geq C_i)$. This is equivalent to $NE(C_i,d_1)$ since d_1 is required to be one time step.

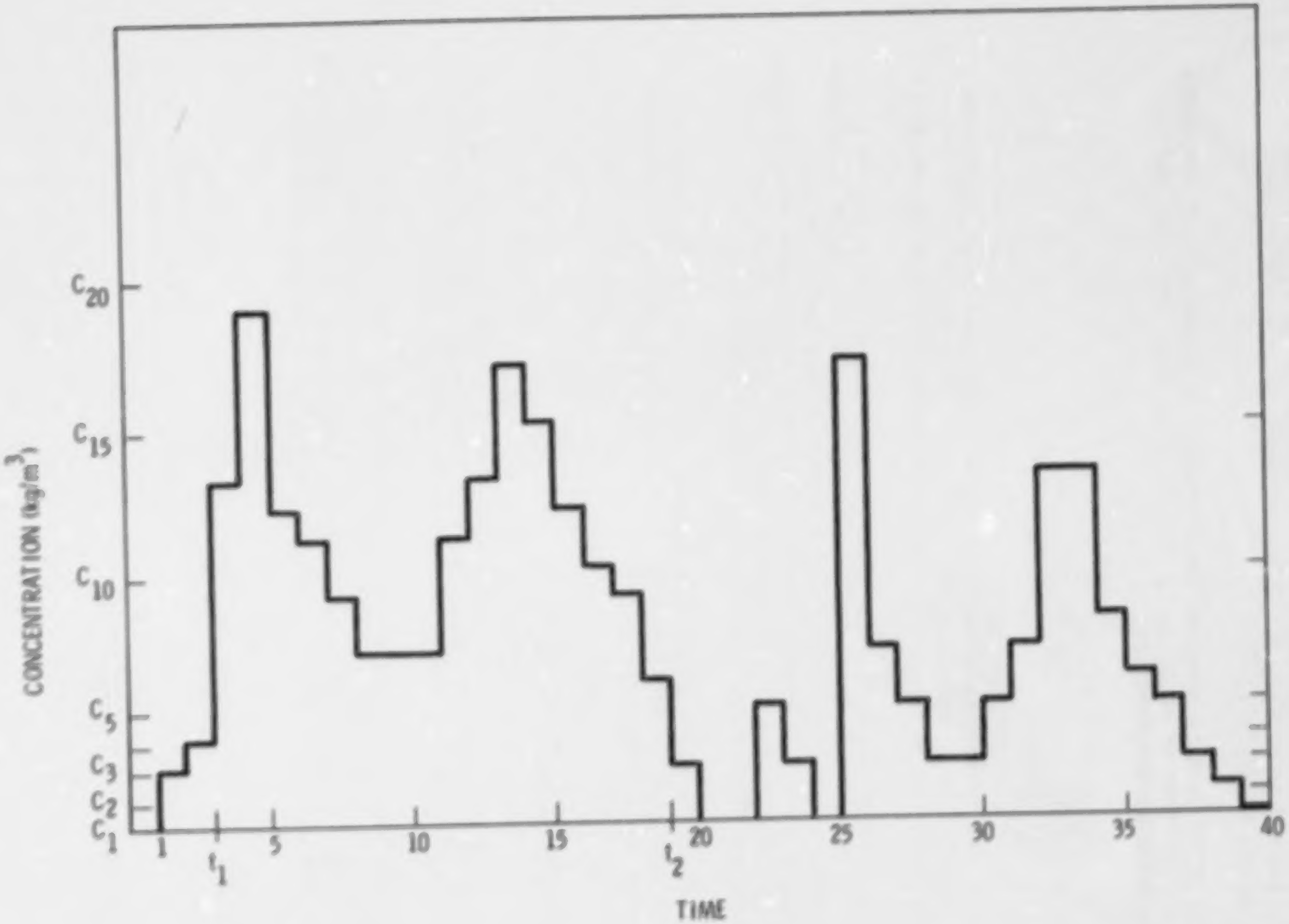

Figure 1. Example of a discrete time step time series of pesticide concentrations.

The second summary is a count of the number of time steps in all events defined by concentration C_i with a duration of d_j or greater. This is denoted as $NT(C_i,d_j)$. When the duration is d_1, $NT(C_i,d_1)$ is equivalent to $NT(C \geq C_i)$.

The third summary measures the frequency of occurrence of concentrations greater than or equal to C_i for all durations. Mathematically, this is given by the fraction:

$$P_T(C \geq C_i) = \frac{\Delta NT(C \geq C_i)}{T}, \; i=1,2,\ldots,m,$$

where T is the total simulation time and Δ is the time in a single time step. $P_T(C \geq C_i)$ is a decreasing function of C_i with $P_T(C \geq 0) = 1$ and $P_T(C > C_{max}) = 0$ where C_{max} is the maximum simulated concentration.

As an illustration of these summary measures, a particular time series may indicate that for 10% of the time the concentration is greater than or equal to C_i, i.e., $P_T(C \geq C_i) = 0.10$. At the same time the total number of events that occurred during that fraction of the time may be 5, i.e., $NE(C > C_i) = 5$. In another case a single event may be responsible for the 10% figure, i.e., $P_T(C \geq C_i) = 0.10$ and $NE(C \geq C_i) = 1$.

The fourth summary gives frequency of occurrence information for events categorized by duration. It is a generalization of the previous summary and is defined as:

$$P_T(C \geq C_i, D \geq d_j) = \frac{\Delta NT(C_i,d_j)}{T}.$$

This gives the fraction of the total time there were events defined by concentration C_i that extended for durations of d_j or greater.

The following two relative frequency summaries only consider events defined by a single concentration level C_i. They are useful when relative frequency information is desired for durations while only considering a single concentration level to define the events. The summaries are:

$$P_E(D \geq d_j | C \geq C_i) = \frac{NE(C_i,d_j)}{NE(C \geq C_i)} \quad \text{and}$$

$$P_T(D \geq d_j | C \geq C_i) = \frac{NT(C_i,d_j)}{NT(C \geq C_i)},$$

for j=1,2,...,n and i=1,2,...,m. They measure relative frequency with respect to the number of events defined by concentration C_i and the amount of time in events defined by concentration C_i, respectively.

Laboratory toxicity experiments provide the main basis for developing a risk analysis for fish. A common method of summarizing the results of these experiments is to use a medium lethal concentration LC50 where 50% of the fish die. A concentration, say C^{96}, is determined such that 50% of the fish die when exposed continuously for a duration of 96 hours, i.e., d^{96}. The previous summaries give:

a) $NE(C^{96},d^{96})$; the number of events defined by C^{96} with durations of 96 hours or greater, and

b) $P_T(C\geq C^{96},D\geq d^{96})$; the fraction of the total time period that the calculated concentration exceeds the 96 hour lethal concentration.

Usually information for LC50 concentrations at 24, 48 and 96 hours is available. This information may be combined in the form of an LC curve. In this study it is assumed that an LC curve is represented by up to five piecewise straight lines, as shown in Figure 2.

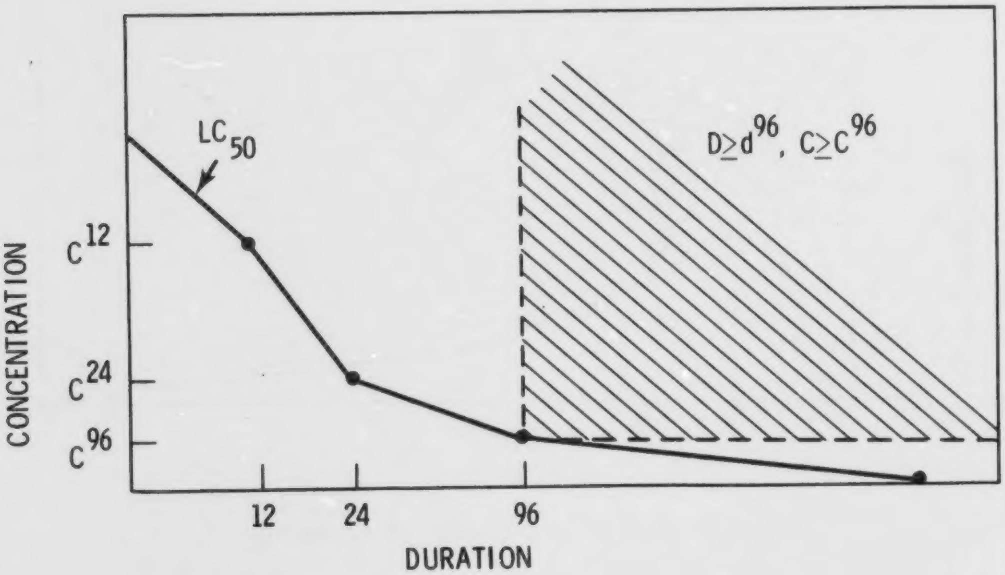

Figure 2. LC50 piecewise linear curves.

The summary NE(C^{96}, d^{96}) is a count of the number of times the calculated concentration time-series meets or exceeds the 96-hr LC50 value (shaded region above the LC50 curve in Figure 2). This is termed a point exceedance of the LC50 curve. Multiple point exceedances can be measured by judicious choices of d_j and C_i in the preceding discussion. $P_T[D \geq d^{96}, C \geq C^{96}]$ gives the fraction of the total time that the time series is in the 96-hr point exceedance.

A more comprehensive measure of exceedance is to obtain the fraction of the total simulation time that the calculated pesticide concentration exceeds a LC50 curve (shaded region above the LC50 curve in Figure 3). This is termed a global exceedance of the LC50 curve. It is defined as:

$$P_G(\text{LC50}) = \frac{\left[\begin{array}{l}\text{number of time steps in distinct events} \\ \text{such that } (C_i, d_j) \text{ is above the LC50 curve}\end{array}\right] \Delta}{T}$$

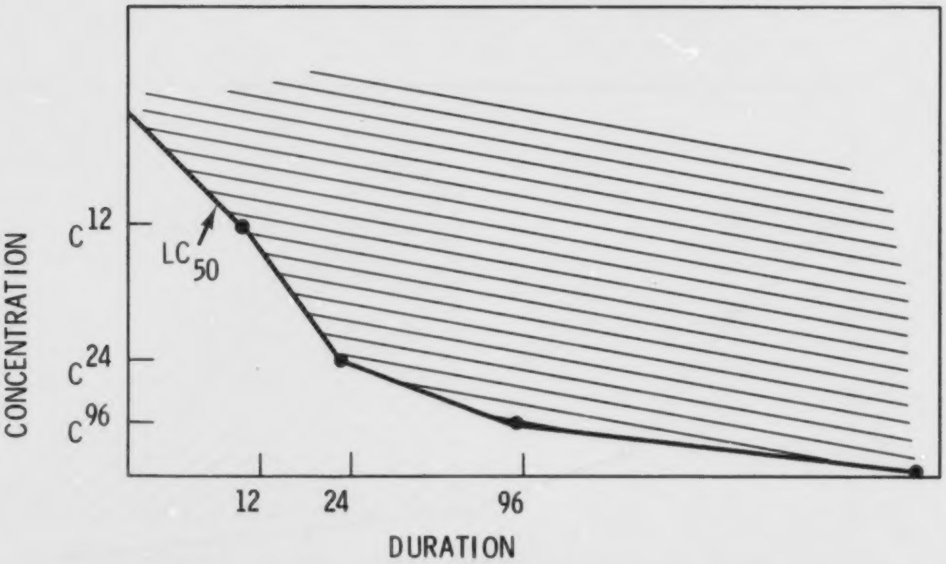

Figure 3. Global exceedance of LC curve.

This summarization can be conducted not only for an LC50 curve but for other LC curves such as LC90, LC10, etc. An example of the use of this summarization involves deciding whether fish will be killed by acute toxicity or chronic toxicity under a certain condition. Assume that the chronic toxicity has a duration of 96 hr or more. In order to obtain the answer, summarization will be conducted for the following cases:
a) Case A has a LC curve shown by the solid line in Figure 3, b) as shown in Figure 4, Case B has a LC50 curve which is the same as the LC50 in Case A for the duration of 96 hr or more but is parallel to the vertical axis at d = 96. P_G for Case A provides the fraction of the total time that 50% of fish will be killed by both acute and chronic toxicity of its pesticide. P_G for Case B provides the fraction of the total time that 50% of fish will be killed by chronic toxicity alone.

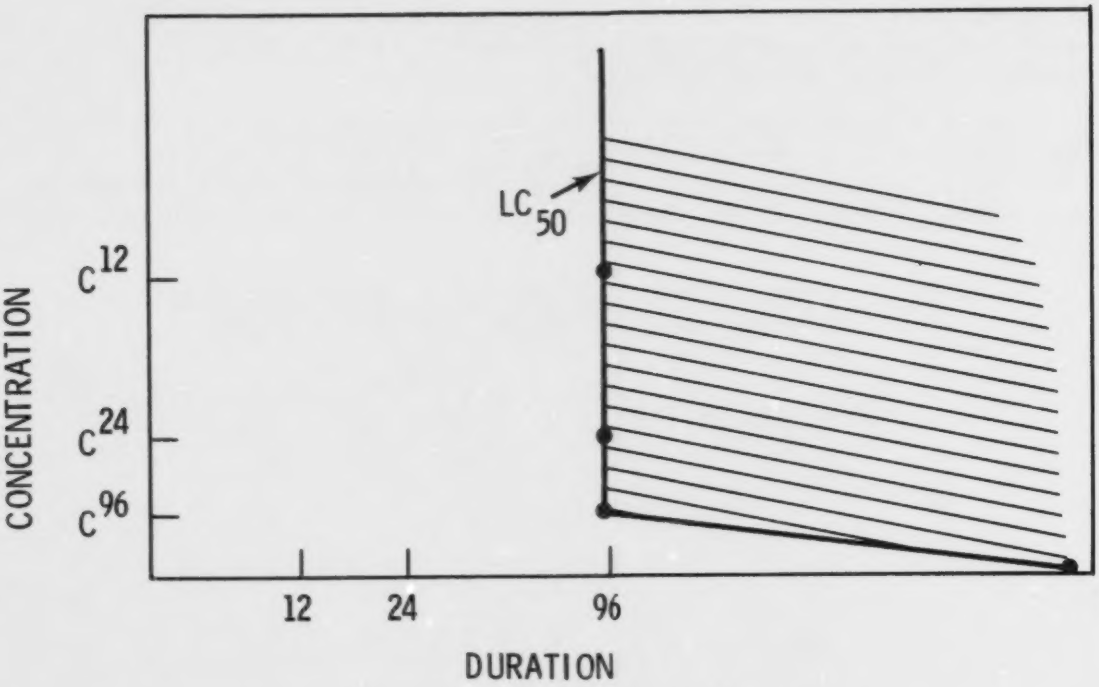

Figure 4. Global exceedance of LC curve for the duration greater than 96 hr.

SECTION 3

HYPOTHETICAL EXAMPLE ILLUSTRATING FRANCO COMPUTATIONS

The statistical summaries based on the concepts in Section 2 are completed by the Frequency Analysis of Concentration (FRANCO) program. The analysis requires a set of concentration values and a set of durations to be specified. The time series is summarized based on these specified values by a count of the number of events defined by concentration level C_i with a duration of d_j or greater. This is denoted by $NE(C_i,d_j)$. A second count is made of the number of time steps occurring for all events defined by concentration level C_i with a duration of d_j or greater. This is denoted by $NT(C_i,d_j)$.

As an example, suppose C_1, C_2, C_4, C_{10}, C_{15}, and C_{20} are the specified concentrations and d_1, d_5, d_{10}, d_{15} and d_{20} are the specified durations. Table 1 presents the number of events defined by concentration levels C_i and duration d_j for the data given in Figure 1.

TABLE 1. NUMBER OF EVENTS DEFINED BY CONCENTRATIONS C_i WITH DURATIONS OF d_j OR GREATER FOR DATA IN FIGURE 1

	Duration				
Concentration	d_1	d_5	d_{10}	d_{15}	d_{20}
C_1	1	1	1	1	1
C_2	3	2	2	1	0
C_4	4	2	1	1	0
C_{10}	4	1	0	0	0
C_{15}	3	0	0	0	0
C_{20}	0	0	0	0	0

Table 2 presents the number of time steps occurring for all events defined by concentration levels C_i and durations d_j. In the example d_1 was selected to be one time step, C_1 to be zero, and C_2 to be a model output cutoff value above which calculated instream dissolved pesticide concentrations are statistically analyzed. These choices are necessary for further analyses to be meaningful. Under these restrictions the total number of time steps in the study period is given by $NT(C_1,d_1)$, the number of time steps with simulated concentrations above the model cutoff by $NT(C_2,d_1)$ and the number of events defined by concentrations above the model cutoff by $NE(C_2,d_1)$.

TABLE 2. NUMBER OF TIME STEPS FOR EVENTS DEFINED BY CONCENTRATIONS C_i WITH DURATIONS OF d_j OR GREATER FOR DATA IN FIGURE 1.

	Duration				
Concentration	d_1	d_5	d_{10}	d_{15}	d_{20}
C_1	40	40	40	40	40
C_2	35	33	33	19	0
C_4	28	24	17	17	0
C_{10}	13	6	0	0	0
C_{15}	4	0	0	0	0
C_{20}	0	0	0	0	0

In addition to the tabular summaries of numbers of events and time steps, a compilation of each individual event defined by the input concentrations C_i is kept internally in FRANCO. This compilation, in the order that is actually completed, is presented in Table 3 to clarify subsequent concepts. Event concentration refers to the concentration level that defines the event.

More specific information is obtained by considering the duration of the events. For example, if a 10-hr LC50 value is given by C_4, then the number of times this occurred, the total time during these occurrences and the percent of time during the study period this LC50 condition was exceeded is available. The number of events is given by $NE(C_4,d_{10})$, the amount of time by $NT(C_4,d_{10})$ and the percent of time by $NT(C_4,d_{10})/NT(C_1,d_1)$. All of these are available as output from FRANCO. This is valuable in the risk assessment methodology as it gives information on whether the instream pesticide concentration exceeds specific laboratory determined LC50 conditions.

If more than one LC50 condition is of interest, then each can be considered separately using the above approach. In that case care in the interpretation of the results is necessary because of possible double counting of times and events. An alternative summary termed global exceedance is given to eliminate double counting. Global exceedance is based on the same concept as an LC50 function. An LC50 function can be

TABLE 3. COMPILATION OF EVENTS IN ORDER OF OCCURRENCE FOR EXAMPLE DATA

Ending Time Step	Number of Time Steps	Event Concentration
5	1	C_{15}
7	4	C_{10}
15	2	C_{15}
17	6	C_{10}
19	17	C_4
20	19	C_2
23	1	C_4
24	2	C_2
26	1	C_{15}
26	1	C_{10}
28	3	C_4
34	2	C_{10}
37	7	C_4
39	14	C_2
40	40	C_1

defined by specifying pairs of concentration and duration values based on LC50 experiments. By connecting these pairs with straight line segments and extending the function in a reasonable manner at each end, a function is defined such that an event defined by a particular concentration level with a particular duration can be classified as exceeding or not exceeding the function i.e., exceeding an LC50 value (see Figure 5). An event exceeds the LC function when the concentration defining the event and the duration of the event results in the pair falling above and to the right of the function. For the example data three events exceed LC function 1 (see Figure 5):

Ending Time Step	Number of Time Steps	Event Concentration
19	17	C_4
17	6	C_{10}
15	2	C_{15}

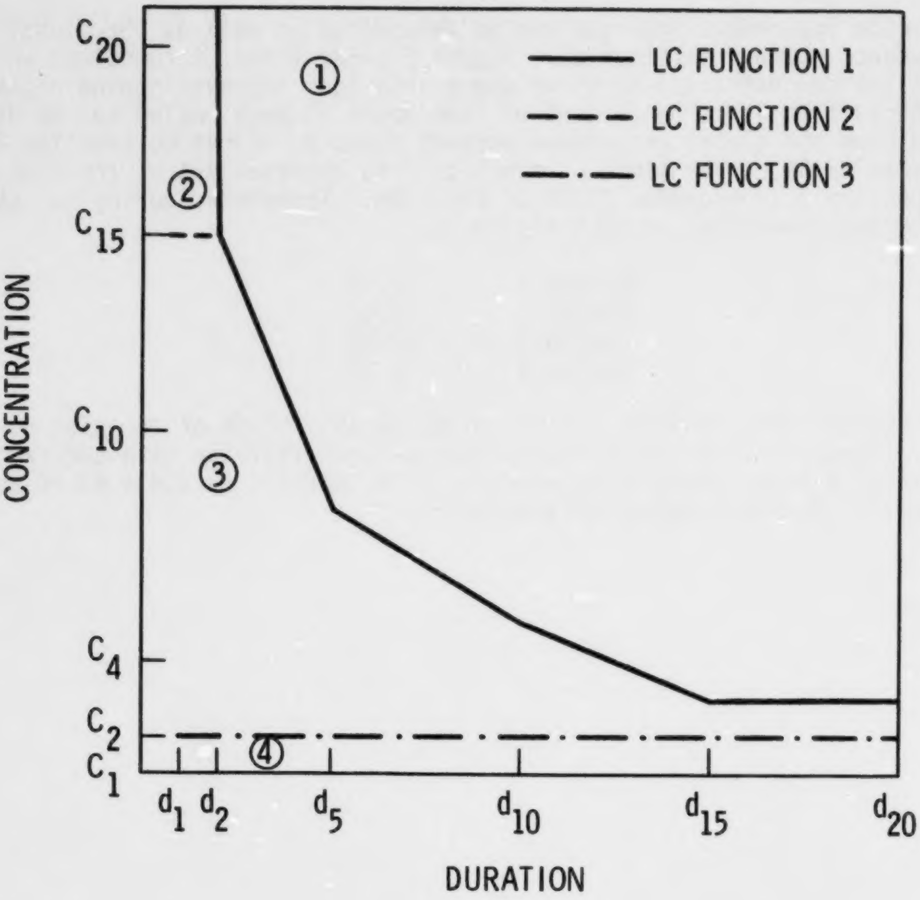

Figure 5. Examples of functions used for global exceedance summary.

However, all three events occur during the same time period of the study, i.e., they consist of different slices of the same pesticide concentration peak. The global exceedance summary eliminates this double counting by reporting only those events with the lowest concentrations that occur in different pesticide peaks. In this case only the event defined by C_4 is reported for LC function 1 in Figure 5. A summary is given of the number of non-overlapping events above the LC function, the time during the study spent above the LC function, expressed as time and as a percent of the total study period.

By selecting different LC functions it is possible to differentiate between short-term high concentration pesticide peaks and long-term low concentration peaks. By specifying the LC function to be the model cutoff concentration for all durations, as in LC function 3, the location of each pesticide occurrence instream can be determined as well as the global exceedance summary information. Figure 5 shows three LC functions which split the concentration-duration space into four non-overlapping regions (numbered 1 to 4). The percent of time spent in each region can be determined from the global exceedance percent summary. First LC function 1 is exceeded 42.5% of the time, LC function 2 is exceeded 45% of the time, and LC function 3 is exceeded 87.5% of the time. Therefore, during the study period the time spent in each region is:

Region 1	42.5%
Region 2	2.5%
Region 3	42.5%
Region 4	12.5%

An interpretation of these numbers might be that 12.5% of the time no significant pesticide concentration was present instream with the remaining 87.5% divided among acute episodes 2.5%, chronic episodes 42.5% and potential but undetermined effects 42.5%.

SECTION 4

FOUR MILE CREEK WATERSHED CASE STUDY

The dissolved pesticide distribution near the mouth of Wolf Creek River Kilometer 5 was selected to illustrate FRANCO analysis procedures. A complete description of the case study can be found in Onishi et al. (1). The pesticide migration was simulated for the three-year period June 1, 1971 to May 31, 1974. The simulation results near the mouth of Wolf Creek were analyzed. A 30-minute time step was used, resulting in 51,264 simulated dissolved pesticide concentrations to be summarized by FRANCO.

Data input for FRANCO requires concentration and duration values to be selected based on the laboratory toxicity information and preliminary information on the concentration and durations expected from the SERATRA simulation. Table 4 summarizes the risk assessment information used in defining the input. SERATRA uses a cutoff value of 1×10^{-9} kg/m^3 for dissolved pesticide concentration. It is assumed that simulated concentrations below that value are zero. This basic information was used to define the input for FRANCO. A complete description of the input procedures is given in Appendix A.

TABLE 4. CONCENTRATION AND DURATIONS FROM RISK ASSESSMENT RELATIVE TO FRANCO INPUT

	LC 50 Concentrations (kg/m^3)	
	Toxaphene	Alachor
24-hour LC50	1.15×10^{-5}	9.6×10^{-3}
48-hour LC50	8.4×10^{-6}	7.8×10^{-3}
96-hour LC50	8.4×10^{-6}	3.7×10^{-3}
MATC	1.5×10^{-8}	1.9×10^{-4}

FRANCO's input procedure presently requires the user to judiciously select the concentrations and durations to be used for summarization. The risk assessment information is used to assure that the basic information desired is available. For this case the seven concentration values in Table 4 and the SERATRA cutoff value were used as concentration input values. A user determined number of concentration values between the input concentrations were logarithmically interpolated by FRANCO. The number to be interpretated is chosen to provide a smooth description of the simulated concentration distribution. A trial and error process is used to obtain approximately an equal number of time steps between successive concentration levels.

The durations selected should include the LC50 durations as well as reflect the durations that are expected to occur or be of interest. In general, as many concentration and durations as FRANCO allows should be used.

The global exceedance summary requires LC curves to be specified as indicated in Section 2. The curves are specified by concentration duration pairs that define the endpoints of each piecewise linear segment. A maximum of five such functions may be specified in a FRANCO run. Detailed procedures for selecting these LC curves are given in the risk assessment methodology description in Onishi et al. (1).

The output available from FRANCO is presented at the end of this section. The information given to control FRANCO is repeated for the convenience of the user. This is followed by five large tables giving detailed information about the frequency of occurrence and duration of dissolved pesticide concentrations. For example, the first table indicates that nine distinct events occurred during the simulation when the concentration exceeded the SERATRA cutoff value. Moreover, these events involved 8,201 time steps (next table) which accounted for 16.0% of the simulation (fifth table). By considering events with longer durations, it is learned that three events with durations greater than 672 hours accounted for 6,193 of the time steps or 12.1% of the total time. This implies that the dissolved pesticide concentration exceeded the cutoff value only a few times but that one-third of these lasted for more than 4 weeks each. At no time did the dissolved pesticide concentration exceed the Alachlor MATC of 1.9×10^{-4}.

FRANCO can also be used to determine the number of events, the number of time steps and the percent of the simulation period the dissolved pesticide concentration exceeded the 24-hr LC50 concentration (1.15×10^{-5}) for toxaphene. In this simulation this occurred twice involving 628 time steps (314 hours) which was 1.2% of the time. Similarly, for the 96-hr LC50 concentration of 8.4×10^{-6}, this occurred twice involving 595 time steps (297.5 hours) or 1.2% of the time. Although the summary statistics do not indicate it, it would be suspected that these two events are the same in both cases. When the 24-hr concentration was exceeded, the concentration was high enough to also exceed the 96-hr value.

A global exceedance summary for five LC curves follows the initial five concentration-duration tables. This summary uses the concepts of global exceedance as defined in Section 2. The five curves are:

- SERATRA cutoff
- MATC for Toxaphene
- Lethality curve least likely to indicate mortality
- LC50-MATC conservative curve
- LC50-MATC alternative curve.

The actual concentration-duration pairs used are given in the FRANCO output. A complete discussion of the rationale behind the curves is given in Onishi et al. (1). The first function is simply a horizontal line at the SERATRA cutoff value. The summary is a repetition of the information contained in previous tables. The second function is set at toxaphene's MATC value for events of any duration, i.e., horizontal line. The summary shows the MATC value was exceeded by 12 distinct events and this accounted for 14.9% of the simulation period. More detailed information can be obtained from previous tables The third function is defined by the three LC50 values with the function extended vertically at 4 hours and horizontally at a concentration of 8.4×10^{-6}. The simulated concentration exceeded this LC function for two distinct events which accounted for 1.2% of the total time. This global summary eliminates the possibility of double counting certain time periods as a result of the concentration exceeding more than one LC50 value, e.g., both the 24-hr and 96-hr LC concentration. It is this aspect that makes the concept of global exceedance useful.

Detailed information about the events exceeding each LC curve is available as optional output from FRANCO. Each event exceeding the LC curve is tabulated by the ending time step of the event, the duration of the event and the concentration level defining the event. For the first LC curve, the location of each event exceeding the SERATRA cutoff value is given.

The remainder of the FRANCO output was designed to characterize the concentration distribution of the dissolved pesticide concentration when both duration and time sequence were ignored. This part of the program was originally implemented as part of a simplified methodology and is not an integral part of the risk assessment summarization. A brief description is included here for completeness.

The FRANCO program summarizes the time series of instream dissolved particulate pesticide concentrations. The series is characterized by periods when pesticide concentration is lower than the chosen SERATRA cutoff value and other periods with runoff events causing the concentration to increase above this value The cutoff value is selected to represent the point below which the simulated concentration values are due to limitations on the numerical accuracy of the model and the computer. Hence, time periods below this concentration are considered to be zero. As a result, the relative frequency of pesticide concentration consists of two parts: A discrete part at the SERATRA cutoff value with an associated frequency that estimates the percent of the time the concentration is considered to be zero and a continuous part that summarizes the relative frequency of concentrations above the cutoff value.

Let C_1 equal zero, C_2 equal the cutoff value and the remaining C_i chosen such that $C_3 < C_4 < \ldots < C_m$. Using the notation introduced in Section 2, this choice results in $P_T[C \geq C_1] = 1$ and $P_T[C \geq C_2]$ equal to the relative frequency that the simulated concentration was greater than or equal to the cutoff value. Define

$$G(C) = pF(C) + (1-p)I(C)$$

where: $p = P_T[C \geq C_2]$ is the relative frequency of concentrations occurring above the cutoff value, $I(C)$ is a discrete cumulative frequency function with probability one at the cutoff value, and $F(C)$ is a continuous distribution function.

During the 3-yr period starting June 1, 1971, the dissolved pesticide concentration was greater than the cutoff value of 1.0×10^{-9} for 16.23% of the time. Hence, p is estimated as 0.1623. The continuous part $F(C)$ of the cumulative distribution function $G(C)$ is well represented by the log-normal distribution. A probability plot constructed from the cumulative frequency concentration data illustrates this fit (see output from FRANCO). Similar probability plots using the normal and gamma distributions as alternative choices did not result in the expected straight line plot characteristic when the data fits a particular probability distribution. The log-normal probability density function is:

$$f(X) = \frac{1}{X \sigma \sqrt{2}} e^{-\frac{1}{2} (\ell n \; X - \;)^2/\sigma^2} \qquad X > 0.$$

Stated in this form, the parameters μ and σ^2 are estimated by

$$\hat{\mu} = \frac{\sum_{i=1}^{n} \ell n \; X_i}{n}$$

$$\hat{\sigma}^2 = \frac{\sum_{i=1}^{n} (\ell n \; X_i - \hat{\mu})^2}{n-1}$$

where n is the number of concentrations greater than the SERATRA cutoff value and X_i are the simulated dissolved pesticide concentrations for those time steps. In this case the estimates are $\hat{\mu} = -14.83$ and $\hat{\sigma} = 2.26$. The mean and variance of the log-normal distribution are

$$E(X) = e^{\mu+\sigma^2/2}$$

$$Var(X) = E(X)^2 \left[e^{\sigma^2} - 1\right]$$

Using the estimated values for μ and σ^2, the estimates are $\widehat{E(X)} = 4.66 \times 10^{-6}$ with a standard deviation of 5.97×10^{-5}.

The statistical distribution summary for the dissolved pesticide concentration is completed by the program FRANCO. The distribution parameter estimates are obtained from all concentrations greater than or equal to the SERATRA cutoff value. Because of the number of time steps involved, these estimates are computed by summarizing the data with a flow-through technique that does not require all the data to be present at once. In constructing the probability plots, a modification of the standard procedure, such as described by Hann (2), was necessary. It was not feasible for all data points to be plotted individually for the probability plot. To overcome this difficulty the data were accumulated as an empirical cumulative distribution function with up to 50 intervals used for the concentration. The probability plot was constructed using those values. The effect on the plot is minimal if these concentration values are appropriately selected to result in approximately an equal number of time steps in each interval. The interpretation of the plot is not affected.

The dissolved pesticide concentration at Wolf Creek River Kilometer 5 is adequately summarized by the mixed distribution:

$$G(C) = 0.1623\,LN(C;-14.83,2.26) + 0.8377\,I(C)$$

where

$$I(C) = \begin{cases} 1 & C \geq 1.0 \times 10^{-9} \\ 0 & C < 1.0 \times 10^{-9} \end{cases}$$

and $LN(C;\mu,\sigma)$ denotes the log-normal distribution with parameters μ and σ. A severe limitation of this summary is the total loss of all information concerning the actual time sequence of the concentrations.

```
                                                          FRANCO
                                                          ------
                                                          ------

                                   SEGMENT 7: DISSOLVED PESTICIDE (KG/M**3) RUN NO, 1
CALCULATED CONCENTRATIONS INPUT FILE NAME              --DP21[106,6]TIMSERIES.DAT
CONCENTRATIONS ARE THE RESULTS FROM                    --A SERATRA SIMULATION
THE DATA FIELD TO BE ANALYSIZED IS NUMBER              --     3
STARTING TIME STEP NUMBER                              --     1
ENDING TIME STEP NUMBER                                --51264
ANALYZING SEGMENT NUMBER                               --     7
ANALYSIS TIME STEP                                     --        0.50 HOUR
DATA ANALYZED IS                                       -- RAW
CONCENTRATION INPUT METHOD                             --     3

THE THIRD METHOD HAS BEEN CHOOSEN FOR INPUTTING CONCENTRATIONS

0,00000E-01 LIMIT FOR RANGE 1
          0 NUMBER OF INTERIM VALUES IN RANGE 1
1,00000E-09 LIMIT FOR RANGE 1

          5 NUMBER OF INTERIM VALUES IN RANGE 2
1,50000E-08 LIMIT FOR RANGE 2

         25 NUMBER OF INTERIM VALUES IN RANGE 3
8,40000E-06 LIMIT FOR RANGE 3

          0 NUMBER OF INTERIM VALUES IN RANGE 4
1,15000E-05 LIMIT FOR RANGE 4

         10 NUMBER OF INTERIM VALUES IN RANGE 5
1,90000E-04 LIMIT FOR RANGE 5

          1 NUMBER OF INTERIM VALUES IN RANGE 6
3,70000E-03 LIMIT FOR RANGE 6

          0 NUMBER OF INTERIM VALUES IN RANGE 7
7,80000E-03 LIMIT FOR RANGE 7

          0 NUMBER OF INTERIM VALUES IN RANGE 8
9,60000E-03 LIMIT FOR RANGE 8

         50 NUMBER OF VALUES (COMPUTED)

                                          SPECIFIED CONCENTRATIONS (CALCULATED)
0,00000E-01  1,09400E-09  1,57042E-09  2,46621E-09  3,87298E-09  6,08220E-09  9,55159E-09  1,50000E-08  1,91333E-08  2,44056E-08
3,11307E-08  3,97089E-08  5,06509E-08  6,46080E-08  8,24110E-08  1,05120E-07  1,34086E-07  1,71035E-07  2,18164E-07  2,78281E-07
3,54963E-07  4,52774E-07  5,77539E-07  7,36683E-07  9,39681E-07  1,19862E-06  1,52890E-06  1,95020E-06  2,48759E-06  3,17306E-06
4,04741E-06  5,16270E-06  6,58531E-06  8,40002E-06  1,15000E-05  1,48399E-05  1,91497E-05  2,47113E-05  3,18880E-05  4,11490E-05
5,30997E-05  6,85211E-05  8,84211E-05  1,14101E-04  1,47238E-04  1,90000E-04  8,38451E-04  3,70000E-03  7,80000E-03  9,60000E-03
      DURATION INPUT METHOD                                     --     1

         20 NUMBER OF SPECIFIED DURATIONS TO BE READ

                                                   SPECIFIED DURATIONS
5,00000E-01  1,20000E+01  2,40000E+01  4,80000E+01  7,20000E+01  9,60000E+01  1,20000E+02  1,44000E+02  1,68000E+02  1,92000E+02
2,16000E+02  2,40000E+02  2,64000E+02  2,88000E+02  3,12000E+02  3,36000E+02  6,72000E+02  1,00800E+03  1,34400E+03  2,68000E+03
      GLOBAL EXCEEDANCE INPUT
          NUMBER OF PIECEWISE LINEAR FUNCTIONS            --     5
          NUMBER OF DURATION, CONCENTRATION PAIRS         --     6
             FUNCTION                      1              2              3              4              5              6
                1       DURATION       5,00000E-01    2,40000E+01    4,80000E+01    9,60000E+01    1,68000E+02    3,36000E+02
                        CONCENTRATION  1,00000E-09    1,00000E-09    1,00000E-09    1,00000E-09    1,00000E-09    1,00000E-09
                2       DURATION       5,00000E-01    2,40000E+01    4,80000E+01    9,60000E+01    1,68000E+02    3,36000E+02
                        CONCENTRATION  1,50000E-08    1,50000E-08    1,50000E-08    1,50000E-08    1,50000E-08    1,50000E-08
                3       DURATION       2,40000E+01    2,40000E+01    4,80000E+01    9,60000E+01    1,68000E+02    3,36000E+02
             →          CONCENTRATION  1,15020E-04←   1,15000E-05←   8,40000E-06    8,40000E-06    8,40000E-06    8,40000E-06
                4       DURATION       5,00000E-01    2,40000E+01    4,80000E+01    9,60000E+01    9,60000E+01    3,36000E+02
                        CONCENTRATION  1,15000E-05    1,15000E-05    8,40000E-06    8,40000E-06    1,50000E-08    1,50000E-08
                5       DURATION       5,00000E-01    2,40000E+01    4,80000E+01    9,60000E+01    1,68000E+02    3,36000E+02
                        CONCENTRATION  1,15000E-05    1,15000E-05    8,40000E-06    8,40000E-06    8,40000E-06    8,40000E-06
      NO LC CONTINUOUS FUNCTION EXCEEDANCE ANALYSIS TO BE PERFORMED
```

```
                      NUMBER OF EVENTS WITH A DURATION OF D(J) OR GREATER
                GIVEN THAT THE EVENT IS DEFINED BY CONCENTRATIONS C(I) OR GREATER
                                            DURATION
                    0.50     12.00     24.00     48.00     72.00     96.00    120.00    144.00    168.00    192.00
CONCENTRATION---------- --------- --------- --------- --------- --------- --------- --------- --------- ---------
  0.00000E-01*         1         1         1         1         1         1         1         1         1         1
  1.00000E-09*         9         9         9         9         9         9         6         6         6         6
  1.57042E-09*         9         9         9         9         9         7         6         6         6         5
  2.46621E-09*         9         9         9         9         9         7         6         6         6         5
  3.87298E-09*         9         9         9         9         9         7         6         6         6         5
  6.08220E-09*         9         9         9         9         8         7         6         6         6         5
  9.55159E-09*        11        11        11        11         9         6         5         5         5         4
  1.50000E-08*        12        12        12        11         7         6         4         4         4         4
  1.91333E-08*        12        12        12        10         7         6         4         4         4         4
  2.44056E-08*        13        13        12        10         8         6         3         3         3         3
  3.11307E-08*        12        12        12        10         8         6         3         3         3         3
  3.97089E-08*        12        12        12        10         7         6         3         3         3         3
  5.06509E-08*        12        12        10         9         7         5         3         3         3         3
  6.46080E-08*        10        10        10         8         6         4         3         3         3         3
  8.24110E-08*        10        10        10         8         6         4         3         3         3         3
  1.05120E-07*        10        10        10         7         6         4         3         3         3         3
  1.34086E-07*        13        11        11         9         5         5         3         3         3         3
  1.71035E-07*        11        11        10         6         4         4         3         3         3         3
  2.18164E-07*        10         9         8         6         4         4         3         3         3         3
  2.78281E-07*        11        11        11         6         5         3         2         2         2         2
  3.54963E-07*        10         9         8         5         4         3         2         2         2         2
  4.52774E-07*         8         6         6         5         3         2         2         2         2         2
  5.77539E-07*         9         8         7         6         5         3         3         2         2         2
  7.36683E-07*         9         9         8         8         5         4         3         3         3         2
  9.39681E-07*         8         8         8         7         5         3         3         3         3         2
  1.19862E-06*         8         8         8         6         5         3         3         3         2         2
  1.52890E-06*         8         8         7         5         4         3         3         3         2         2
  1.95020E-06*         8         8         7         6         4         3         3         3         2         2
  2.48759E-06*         7         7         6         6         4         3         3         3         2         1
  3.17306E-06*         6         6         6         4         3         3         3         2         2         1
  4.04741E-06*         6         6         6         4         3         3         3         2         1         1
  5.16270E-06*         5         5         5         3         3         3         3         1         1         1
  6.58531E-06*         3         3         3         2         2         2         2         1         1         1
  8.40000E-06*         2         2         2         2         2         2         1         1         1         1
  1.15000E-05*         2         2         2         2         2         2         1         1         1         0
  1.48399E-05*         2         2         2         2         2         2         1         1         1         0
  1.91497E-05*         2         2         2         2         2         1         1         1         1         0
  2.47113E-05*         2         2         2         2         2         1         1         1         1         0
  3.18880E-05*         2         2         2         1         1         1         1         1         0         0
  4.11490E-05*         2         2         2         2         1         0         0         0         0         0
  5.30997E-05*         2         2         2         2         0         0         0         0         0         0
  6.85211E-05*         1         1         1         1         0         0         0         0         0         0
  8.84211E-05*         1         1         1         0         0         0         0         0         0         0
  1.14101E-04*         1         1         1         0         0         0         0         0         0         0
  1.47238E-04*         1         1         1         0         0         0         0         0         0         0
  1.90000E-04*         0         0         0         0         0         0         0         0         0         0
  8.38451E-04*         0         0         0         0         0         0         0         0         0         0
  3.70000E-03*         0         0         0         0         0         0         0         0         0         0
  7.80000E-03*         0         0         0         0         0         0         0         0         0         0
  9.60000E-03*         0         0         0         0         0         0         0         0         0         0
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                                                       DURATION

                   216.00    240.00    264.00    288.00    312.00    336.00    672.00   1008.00   1344.00   2688.00
CONCENTRATION--------- --------- --------- --------- --------- --------- --------- --------- --------- ---------
 0.00000E-01*          1         1         1         1         1         1         1         1         1         1
 1.00000E-09*          5         5         4         4         3         3         3         2         0         0
 1.57042E-09*          5         5         4         3         3         3         3         2         0         0
 2.46621E-09*          5         5         4         3         3         3         3         2         0         0
 3.87298E-09*          5         4         4         3         3         3         3         2         0         0
 6.08220E-09*          5         4         4         3         3         3         3         2         0         0
 9.55159E-09*          4         3         3         3         3         3         3         1         0         0
 1.50000E-08*          4         3         3         3         3         3         3         1         0         0
 1.91333E-08*          3         3         3         3         3         3         3         1         0         0
 2.44056E-08*          3         3         3         3         3         3         3         1         0         0
 3.11307E-08*          3         3         3         3         3         3         3         1         0         0
 3.97089E-08*          3         3         3         3         3         3         3         1         0         0
 5.06509E-08*          3         3         3         3         3         3         3         1         0         0
 6.46086E-08*          3         3         3         3         3         3         3         1         0         0
 8.24116E-08*          3         3         3         3         3         3         3         1         0         0
 1.05120E-07*          3         3         3         3         3         3         3         1         0         0
 1.34086E-07*          3         2         2         2         2         2         2         1         0         0
 1.71035E-07*          2         2         2         2         2         2         2         1         0         0
 2.18168E-07*          2         2         2         2         2         2         2         1         0         0
 2.78281E-07*          2         2         2         2         2         2         1         0         0         0
 3.54963E-07*          2         2         2         2         2         2         1         0         0         0
 4.52774E-07*          2         2         2         2         2         2         1         0         0         0
 5.77539E-07*          2         2         2         2         2         2         1         0         0         0
 7.36683E-07*          2         2         2         2         1         0         0         0         0         0
 9.39681E-07*          2         2         2         2         0         0         0         0         0         0
 1.19862E-06*          2         2         2         2         0         0         0         0         0         0
 1.52890E-06*          2         2         2         0         0         0         0         0         0         0
 1.95020E-06*          1         1         1         0         0         0         0         0         0         0
 2.48759E-06*          1         1         1         0         0         0         0         0         0         0
 3.17306E-06*          1         1         1         0         0         0         0         0         0         0
 4.04741E-06*          1         1         0         0         0         0         0         0         0         0
 5.16270E-06*          0         0         0         0         0         0         0         0         0         0
 6.58531E-06*          0         0         0         0         0         0         0         0         0         0
 8.40000E-06*          0         0         0         0         0         0         0         0         0         0
 1.15000E-05*          0         0         0         0         0         0         0         0         0         0
 1.48399E-05*          0         0         0         0         0         0         0         0         0         0
 1.91497E-05*          0         0         0         0         0         0         0         0         0         0
 2.47113E-05*          0         0         0         0         0         0         0         0         0         0
 3.18880E-05*          0         0         0         0         0         0         0         0         0         0
 4.11490E-05*          0         0         0         0         0         0         0         0         0         0
 5.30997E-05*          0         0         0         0         0         0         0         0         0         0
 6.85211E-05*          0         0         0         0         0         0         0         0         0         0
 8.84211E-05*          0         0         0         0         0         0         0         0         0         0
 1.14101E-04*          0         0         0         0         0         0         0         0         0         0
 1.47238E-04*          0         0         0         0         0         0         0         0         0         0
 1.90000E-04*          0         0         0         0         0         0         0         0         0         0
 8.38451E-04*          0         0         0         0         0         0         0         0         0         0
 3.70000E-03*          0         0         0         0         0         0         0         0         0         0
 7.80000E-03*          0         0         0         0         0         0         0         0         0         0
 9.60000E-03*          0         0         0         0         0         0         0         0         0         0
```

```
                    NUMBER OF TIME PLANES WITH DURATIONS OF D(J) OR GREATER OCCUR
                    GIVEN THAT THE EVENT IS DEFINED BYCONCENTRATIONS C(I) OR GREATER
                                              DURATION

                     0.50     12.00      24.00      48.00      72.00      96.00     120.00     144.00     168.00     192.00
CONCENTRATION--------- ---------  ---------  ---------  ---------  ---------  ---------  ---------  ---------  ---------
 0.00000E-01*       51264     51264      51264      51264      51264      51264      51264      51264      51264      51264
 1.00000E-09*        8320      8320       8320       8320       8320       8320       7712       7712       7712       7712
 1.57042E-09*        8238      8238       8238       8238       8238       7870       7652       7652       7652       7270
 2.46621E-09*        8150      8150       8150       8150       8150       7804       7587       7587       7587       7217
 3.87298E-09*        8058      8058       8058       8058       8058       7735       7519       7519       7519       7162
 6.08220E-09*        7965      7965       7965       7965       7823       7666       7451       7451       7451       7106
 9.55159E-09*        7828      7828       7828       7828       7576       7089       6876       6876       6876       6527
 1.50000E-08*        7656      7656       7656       7582       7096       6923       6476       6476       6476       6476
 1.91333E-08*        7558      7558       7558       7405       7047       6882       6445       6445       6445       6445
 2.44056E-08*        7438      7438       7398       7227       6983       6648       5990       5990       5990       5990
 3.11307E-08*        7296      7296       7296       7149       6922       6606       5966       5966       5966       5966
 3.97089E-08*        7189      7189       7189       7071       6722       6562       5942       5942       5942       5942
 5.06509E-08*        7060      7060       6902       6889       6663       6322       5915       5915       5915       5915
 6.46080E-08*        6891      6891       6891       6720       6463       6094       5889       5889       5889       5889
 8.24110E-08*        6785      6785       6785       6640       6406       6061       5857       5857       5857       5857
 1.05120E-07*        6663      6663       6663       6458       6340       6023       5821       5821       5821       5821
 1.34086E-07*        5353      5309       5309       5179       4668       4668       4269       4269       4269       4269
 1.71035E-07*        4949      4949       4911       4614       4343       4343       4144       4144       4144       4144
 2.18164E-07*        4684      4672       4646       4498       4281       4281       4084       4084       4084       4084
 2.78281E-07*        4203      4203       4203       3847       3746       3414       3219       3219       3219       3219
 3.54963E-07*        3859      3854       3826       3621       3508       3349       3157       3157       3157       3157
 4.52774E-07*        3627      3610       3610       3542       3313       3123       3123       3123       3123       3123
 5.77539E-07*        3372      3354       3323       3253       3136       2794       2794       2553       2553       2553
 7.36683E-07*        2416      2416       2383       2383       2010       1827       1614       1614       1614       1247
 9.39681E-07*        2207      2207       2207       2121       1896       1543       1543       1543       1543       1201
 1.19862E-06*        2076      2076       2076       1921       1821       1496       1496       1496       1169       1169
 1.52890E-06*        1949      1949       1902       1756       1623       1453       1453       1453       1138       1138
 1.95020E-06*        1750      1750       1722       1658       1418       1255       1255       1255        951        951
 2.48759E-06*        1600      1600       1571       1571       1367       1212       1212       1212        919        542
 3.17306E-06*        1476      1476       1476       1310       1167       1167       1167        885        885        531
 4.04741E-06*        1363      1363       1363       1240       1117       1117       1117        846        519        519
 5.16270E-06*        1093      1093       1093        963        963        963        963        419        419        419
 6.58531E-06*         703       703        703        653        653        653        653        404        404        404
 8.40000E-06*         628       628        628        628        628        628        393        393        393        393
 1.15000E-05*         595       595        595        595        595        595        378        378        378          0
 1.48399E-05*         563       563        563        563        563        563        365        365        365          0
 1.91497E-05*         529       529        529        529        529        353        353        353        353          0
 2.47113E-05*         484       484        484        484        484        339        339        339        339          0
 3.18880E-05*         389       389        389        322        322        322        322        322          0          0
 4.11490E-05*         293       293        293        293        154          0          0          0          0          0
 5.30997E-05*         227       227        227        227          0          0          0          0          0          0
 6.85211E-05*         108       108        108        108          0          0          0          0          0          0
 8.84211E-05*          93        93         93          0          0          0          0          0          0          0
 1.14101E-04*          75        75         75          0          0          0          0          0          0          0
 1.47238E-04*          52        52         52          0          0          0          0          0          0          0
 1.90000E-04*           0         0          0          0          0          0          0          0          0          0
 8.38451E-04*           0         0          0          0          0          0          0          0          0          0
 3.70000E-03*           0         0          0          0          0          0          0          0          0          0
 7.80000E-03*           0         0          0          0          0          0          0          0          0          0
 9.60000E-03*           0         0          0          0          0          0          0          0          0          0
```

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                                                      DURATION

                  216,00     240,00     264,00     288,00     312,00     336,00     672,00    1008,00    1344,00    2688,00
CONCENTRATION--------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
  0,00000E-01*     51264      51264      51264      51264      51264      51264      51264      51264      51264      51264
  1,00000E-09*      7319       7319       6815       6815       6235       6235       6235       4641          0          0
  1,57042E-09*      7270       7270       6776       6207       6207       6207       6207       4622          0          0
  2,46621E-09*      7217       7217       6734       6177       6177       6177       6177       4602          0          0
  3,87298E-09*      7162       6690       6690       6145       6145       6145       6145       4580          0          0
  6,08220E-09*      7106       6645       6645       6113       6113       6113       6113       4559          0          0
  9,55159E-09*      6527       6078       6078       6078       6078       6078       6078       2527          0          0
  1,50000E-08*      6476       6039       6039       6039       6039       6039       6039       2515          0          0
  1,91333E-08*      6016       6016       6016       6016       6016       6016       6016       2509          0          0
  2,44056E-08*      5990       5990       5990       5990       5990       5990       5990       2502          0          0
  3,11307E-08*      5966       5966       5966       5966       5966       5966       5966       2495          0          0
  3,97089E-08*      5942       5942       5942       5942       5942       5942       5942       2487          0          0
  5,06509E-08*      5915       5915       5915       5915       5915       5915       5915       2478          0          0
  6,46080E-08*      5889       5889       5889       5889       5889       5889       5889       2469          0          0
  8,24110E-08*      5857       5857       5857       5857       5857       5857       5857       2459          0          0
  1,05120E-07*      5821       5821       5821       5821       5821       5821       5821       2447          0          0
  1,34086E-07*      4269       3803       3803       3803       3803       3803       3803       2158          0          0
  1,71035E-07*      3719       3719       3719       3719       3719       3719       3719       2117          0          0
  2,18164E-07*      3678       3678       3678       3678       3678       3678       3678       2097          0          0
  2,78281E-07*      3219       3219       3219       3219       3219       3219       1956          0          0          0
  3,54963E-07*      3157       3157       3157       3157       3157       3157       1926          0          0          0
  4,52774E-07*      3123       3123       3123       3123       3123       3123       1910          0          0          0
  5,77539E-07*      2553       2553       2553       2553       2553       2553       1630          0          0          0
  7,36683E-07*      1247       1247       1247       1247        630          0          0          0          0          0
  9,39681E-07*      1201       1201       1201       1201          0          0          0          0          0          0
  1,19862E-06*      1169       1169       1169       1169          0          0          0          0          0          0
  1,52890E-06*      1138       1138       1138          0          0          0          0          0          0          0
  1,95020E-06*       553        553        553          0          0          0          0          0          0          0
  2,48759E-06*       542        542        542          0          0          0          0          0          0          0
  3,17306E-06*       531        531        531          0          0          0          0          0          0          0
  4,04741E-06*       519        519          0          0          0          0          0          0          0          0
  5,16270E-06*         0          0          0          0          0          0          0          0          0          0
  6,58531E-06*         0          0          0          0          0          0          0          0          0          0
  8,40000E-06*         0          0          0          0          0          0          0          0          0          0
  1,15000E-05*         0          0          0          0          0          0          0          0          0          0
  1,48399E-05*         0          0          0          0          0          0          0          0          0          0
  1,91497E-05*         0          0          0          0          0          0          0          0          0          0
  2,47113E-05*         0          0          0          0          0          0          0          0          0          0
  3,18880E-05*         0          0          0          0          0          0          0          0          0          0
  4,11490E-05*         0          0          0          0          0          0          0          0          0          0
  5,30997E-05*         0          0          0          0          0          0          0          0          0          0
  6,85211E-05*         0          0          0          0          0          0          0          0          0          0
  8,84211E-05*         0          0          0          0          0          0          0          0          0          0
  1,14101E-04*         0          0          0          0          0          0          0          0          0          0
  1,47238E-04*         0          0          0          0          0          0          0          0          0          0
  1,90000E-04*         0          0          0          0          0          0          0          0          0          0
  8,38451E-04*         0          0          0          0          0          0          0          0          0          0
  3,70000E-03*         0          0          0          0          0          0          0          0          0          0
  7,80000E-03*         0          0          0          0          0          0          0          0          0          0
  9,60000E-03*         0          0          0          0          0          0          0          0          0          0
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                    PERCENTAGE OF EVENTS WITH A DURATION OF D(J) OR GREATER
                  GIVEN THAT THE EVENT IS DEFINED BY CONCENTRATIONS C(I) OR GREATER
                                          DURATION

                      0.50      12.00      24.00      48.00      72.00      96.00     120.00     144.00     168.00     192.00
CONCENTRATION----------  ---------  ---------  ---------  ---------  ---------  ---------  ---------  ---------  ---------
 0.00000E-01*        100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0
 1.00000E-09*        100.0      100.0      100.0      100.0      100.0      100.0       66.7       66.7       66.7       66.7
 1.57042E-09*        100.0      100.0      100.0      100.0      100.0       77.8       66.7       66.7       66.7       55.6
 2.46621E-09*        100.0      100.0      100.0      100.0      100.0       77.8       66.7       66.7       66.7       55.6
 3.87298E-09*        100.0      100.0      100.0      100.0      100.0       77.8       66.7       66.7       66.7       55.6
 6.08220E-09*        100.0      100.0      100.0      100.0       88.9       77.8       66.7       66.7       66.7       55.6
 9.55159E-09*        100.0      100.0      100.0      100.0       81.8       54.5       45.5       45.5       45.5       36.4
 1.50000E-08*        100.0      100.0      100.0       91.7       58.3       50.0       33.3       33.3       33.3       33.3
 1.91333E-08*        100.0      100.0      100.0       83.3       58.3       50.0       33.3       33.3       33.3       33.3
 2.44056E-08*        100.0      100.0       92.3       76.9       61.5       46.2       23.1       23.1       23.1       23.1
 3.11307E-08*        100.0      100.0      100.0       83.3       66.7       50.0       25.0       25.0       25.0       25.0
 3.97089E-08*        100.0      100.0      100.0       83.3       58.3       50.0       25.0       25.0       25.0       25.0
 5.06509E-08*        100.0      100.0       83.3       75.0       58.3       41.7       25.0       25.0       25.0       25.0
 6.46086E-08*        100.0      100.0      100.0       80.0       60.0       40.0       30.0       30.0       30.0       30.0
 8.24110E-08*        100.0      100.0      100.0       80.0       60.0       40.0       30.0       30.0       30.0       30.0
 1.05120E-07*        100.0      100.0      100.0       70.0       60.0       40.0       30.0       30.0       30.0       30.0
 1.34086E-07*        100.0       84.6       84.6       69.2       38.5       38.5       23.1       23.1       23.1       23.1
 1.71035E-07*        100.0      100.0       90.9       54.5       36.4       36.4       27.3       27.3       27.3       27.3
 2.18164E-07*        100.0       90.0       80.0       60.0       40.0       40.0       30.0       30.0       30.0       30.0
 2.78281E-07*        100.0      100.0      100.0       54.5       45.5       27.3       18.2       18.2       18.2       18.2
 3.54963E-07*        100.0       90.0       80.0       50.0       40.0       30.0       20.0       20.0       20.0       20.0
 4.52774E-07*        100.0       75.0       75.0       62.5       37.5       25.0       25.0       25.0       25.0      250
 5.77539E-07*        100.0       88.9       77.8       66.7       55.6       33.3       33.3       22.2       22.2       22.2
 7.36683E-07*        100.0      100.0       88.9       88.9       55.6       44.4       33.3       33.3       33.3       22.2
 9.39681E-07*        100.0      100.0      100.0       87.5       62.5       37.5       37.5       37.5       37.5       25.0
 1.19862E-06*        100.0      100.0      100.0       75.0       62.5       37.5       37.5       37.5       25.0       25.0
 1.52890E-06*        100.0      100.0       87.5       62.5       50.0       37.5       37.5       37.5       25.0       25.0
 1.95020E-06*        100.0      100.0       87.5       75.0       50.0       37.5       37.5       37.5       25.0       25.0
 2.48759E-06*        100.0      100.0       85.7       85.7       57.1       42.9       42.9       42.9       28.6       14.3
 3.17306E-06*        100.0      100.0      100.0       66.7       50.0       50.0       50.0       33.3       33.3       16.7
 4.04741E-06*        100.0      100.0      100.0       66.7       50.0       50.0       50.0       33.3       16.7       16.7
 5.16270E-06*        100.0      100.0      100.0       60.0       60.0       60.0       60.0       20.0       20.0       20.0
 6.58531E-06*        100.0      100.0      100.0       66.7       66.7       66.7       66.7       33.3       33.3       33.3
 8.40000E-06*        100.0      100.0      100.0      100.0      100.0      100.0       50.0       50.0       50.0       50.0
 1.15000E-05*        100.0      100.0      100.0      100.0      100.0      100.0       50.0       50.0       50.0        0.0
 1.48399E-05*        100.0      100.0      100.0      100.0      100.0      100.0       50.0       50.0       50.0        0.0
 1.91497E-05*        100.0      100.0      100.0      100.0      100.0       50.0       50.0       50.0       50.0        0.0
 2.47113E-05*        100.0      100.0      100.0      100.0      100.0       50.0       50.0       50.0       50.0        0.0
 3.18880E-05*        100.0      100.0      100.0       50.0       50.0       50.0       50.0       50.0        0.0        0.0
 4.11490E-05*        100.0      100.0      100.0      100.0       50.0        0.0        0.0        0.0        0.0        0.0
 5.30997E-05*        100.0      100.0      100.0      100.0        0.0        0.0        0.0        0.0        0.0        0.0
 6.85211E-05*        100.0      100.0      100.0      100.0        0.0        0.0        0.0        0.0        0.0        0.0
 8.84211E-05*        100.0      100.0      100.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.14101E-04*        100.0      100.0      100.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.47230E-04*        100.0      100.0      100.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.90000E-04*          0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 8.30451E-04*          0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 3.70000E-03*          0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 7.80000E-03*          0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 9.60000E-03*          0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
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                                                           DURATION

                   216.00     240.00     264.00     288.00     312.00     336.00     672.00    1008.00    1344.00    2688.00
CONCENTRATION---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
  0.00000E-01*      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0
  1.00000E-09*       55.6       55.6       44.4       44.4       33.3       33.3       33.3       22.2        0.0        0.0
  1.57042E-09*       55.6       55.6       44.4       33.3       33.3       33.3       33.3       22.2        0.0        0.0
  2.46621E-09*       55.6       55.6       44.4       33.3       33.3       33.3       33.3       22.2        0.0        0.0
  3.87298E-09*       55.6       44.4       44.4       33.3       33.3       33.3       33.3       22.2        0.0        0.0
  6.08220E-09*       55.6       44.4       44.4       33.3       33.3       33.3       33.3       22.2        0.0        0.0
  9.55159E-09*       36.4       27.3       27.3       27.3       27.3       27.3       27.3        9.1        0.0        0.0
  1.50000E-08*       33.3       25.0       25.0       25.0       25.0       25.0       25.0        8.3        0.0        0.0
  1.91333E-08*       25.0       25.0       25.0       25.0       25.0       25.0       25.0        8.3        0.0        0.0
  2.44056E-08*       23.1       23.1       23.1       23.1       23.1       23.1       23.1        7.7        0.0        0.0
  3.11307E-08*       25.0       25.0       25.0       25.0       25.0       25.0       25.0        8.3        0.0        0.0
  3.97089E-08*       25.0       25.0       25.0       25.0       25.0       25.0       25.0        8.3        0.0        0.0
  5.06509E-08*       25.0       25.0       25.0       25.0       25.0       25.0       25.0        8.3        0.0        0.0
  6.46080E-08*       30.0       30.0       30.0       30.0       30.0       30.0       30.0       10.0        0.0        0.0
  8.24110E-08*       30.0       30.0       30.0       30.0       30.0       30.0       30.0       10.0        0.0        0.0
  1.05120E-07*       30.0       30.0       30.0       30.0       30.0       30.0       30.0       10.0        0.0        0.0
  1.34086E-07*       23.1       15.4       15.4       15.4       15.4       15.4       15.4        7.7        0.0        0.0
  1.71035E-07*       18.2       18.2       18.2       18.2       18.2       18.2       18.2        9.1        0.0        0.0
  2.18164E-07*       20.0       20.0       20.0       20.0       20.0       20.0       20.0       10.0        0.0        0.0
  2.78281E-07*       18.2       18.2       18.2       18.2       18.2       18.2        9.1        0.0        0.0        0.0
  3.54963E-07*       20.0       20.0       20.0       20.0       20.0       20.0       10.0        0.0        0.0        0.0
  4.52774E-07*       25.0       25.0       25.0       25.0       25.0       25.0       12.5        0.0        0.0        0.0
  5.77539E-07*       22.2       22.2       22.2       22.2       22.2       22.2       11.1        0.0        0.0        0.0
  7.36683E-07*       22.2       22.2       22.2       22.2       11.1        0.0        0.0        0.0        0.0        0.0
  9.39681E-07*       25.0       25.0       25.0       25.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.19862E-06*       25.0       25.0       25.0       25.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.52890E-06*       25.0       25.0       25.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.95020E-06*       12.5       12.5       12.5        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  2.48759E-06*       14.3       14.3       14.3        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  3.17306E-06*       16.7       16.7       16.7        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  4.04741E-06*       16.7       16.7        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  5.16270E-06*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  6.58531E-06*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  8.40000E-06*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.15000E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.48399E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.91497E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  2.47113E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  3.18866E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  4.11490E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  5.30997E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  6.85211E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  8.84211E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.14101E-04*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.47230E-04*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.90000E-04*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  8.38451E-04*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  3.70000E-03*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  7.80000E-03*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  9.60000E-03*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
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                    PERCENTAGE OF TIME EVENTS WITH DURATIONS OF D(J) OR GREATER OCCUR
                    GIVEN THAT THE EVENT IS DEFINED BYCONCENTRATIONS C(I) OR GREATER
                                                 DURATION

                      0.50      12.00      24.00      48.00      72.00      96.00     120.00     144.00     168.00     192.00
CONCENTRATION-------------  ---------  ---------  ---------  ---------  ---------  ---------  ---------  ---------  ---------
 0.00000E-01*        100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0
 1.00000E-09*        100.0      100.0      100.0      100.0      100.0      100.0       92.7       92.7       92.7       92.7
 1.57042E-09*        100.0      100.0      100.0      100.0      100.0       95.5       92.9       92.9       92.9       88.2
 2.46621E-09*        100.0      100.0      100.0      100.0      100.0       95.8       93.1       93.1       93.1       88.6
 3.87298E-09*        100.0      100.0      100.0      100.0      100.0       96.0       93.3       93.3       93.3       88.9
 6.08220E-09*        100.0      100.0      100.0      100.0       98.2       96.2       93.5       93.5       93.5       89.2
 9.55159E-09*        100.0      100.0      100.0      100.0       96.8       90.6       87.8       87.8       87.8       83.4
 1.50000E-08*        100.0      100.0      100.0       99.0       92.7       90.4       84.6       84.6       84.6       84.6
 1.91333E-08*        100.0      100.0      100.0       98.0       93.2       91.1       85.3       85.3       85.3       85.3
 2.44056E-08*        100.0      100.0       99.5       97.2       93.9       89.4       80.5       80.5       80.5       80.5
 3.11307E-08*        100.0      100.0      100.0       98.0       94.9       90.5       81.8       81.8       81.8       81.8
 3.97089E-08*        100.0      100.0      100.0       98.4       93.5       91.3       82.7       82.7       82.7       82.7
 5.06509E-08*        100.0      100.0       98.9       97.6       94.4       89.5       83.8       83.8       83.8       83.8
 6.46080E-08*        100.0      100.0      100.0       97.5       93.8       88.4       85.5       85.5       85.5       85.5
 8.24110E-08*        100.0      100.0      100.0       97.9       94.4       89.3       86.3       86.3       86.3       86.3
 1.05120E-07*        100.0      100.0      100.0       96.9       95.2       90.4       87.4       87.4       87.4       87.4
 1.34086E-07*        100.0       99.2       99.2       96.7       87.2       87.2       79.7       79.7       79.7       79.7
 1.71035E-07*        100.0      100.0       99.2       93.2       87.8       87.8       83.7       83.7       83.7       83.7
 2.18164E-07*        100.0       99.7       99.2       96.0       91.4       91.4       87.2       87.2       87.2       87.2
 2.78281E-07*        100.0      100.0      100.0       91.5       89.1       81.2       76.6       76.6       76.6       76.6
 3.54963E-07*        100.0       99.9       99.1       93.8       90.7       86.8       81.8       81.8       81.8       81.8
 4.52774E-07*        100.0       99.5       99.5       97.7       91.3       86.1       86.1       86.1       86.1       86.1
 5.77539E-07*        100.0       99.5       98.5       96.5       93.0       82.9       82.9       75.7       75.7       75.7
 7.36683E-07*        100.0      100.0       98.6       98.6       83.2       75.6       66.8       66.8       66.8       51.6
 9.39681E-07*        100.0      100.0      100.0       96.1       85.9       69.9       69.9       69.9       69.9       54.4
 1.19862E-06*        100.0      100.0      100.0       92.5       87.7       72.1       72.1       72.1       56.3       56.3
 1.52890E-06*        100.0      100.0       97.6       90.1       83.3       74.6       74.6       74.6       58.4       58.4
 1.95020E-06*        100.0      100.0       98.4       94.7       81.0       71.7       71.7       71.7       54.3       54.3
 2.48759E-06*        100.0      100.0       98.2       98.2       85.4       75.8       75.8       75.8       57.4       33.9
 3.17306E-06*        100.0      100.0      100.0       88.8       79.1       79.1       79.1       60.0       60.0       36.0
 4.04741E-06*        100.0      100.0      100.0       91.0       82.0       82.0       82.0       62.1       38.1       38.1
 5.16270E-06*        100.0      100.0      100.0       88.1       88.1       88.1       88.1       38.3       38.3       38.3
 6.58531E-06*        100.0      100.0      100.0       92.9       92.9       92.9       92.9       57.5       57.5       57.5
 8.40000E-06*        100.0      100.0      100.0      100.0      100.0      100.0       62.6       62.6       62.6       62.6
 1.15000E-05*        100.0      100.0      100.0      100.0      100.0      100.0       63.5       63.5       63.5        0.0
 1.48399E-05*        100.0      100.0      100.0      100.0      100.0      100.0       64.8       64.8       64.8        0.0
 1.91497E-05*        100.0      100.0      100.0      100.0      100.0       66.7       66.7       66.7       66.7        0.0
 2.47113E-05*        100.0      100.0      100.0      100.0      100.0       70.0       70.0       70.0       70.0        0.0
 3.18880E-05*        100.0      100.0      100.0       82.8       82.8       82.8       82.8       82.8        0.0        0.0
 4.11490E-05*        100.0      100.0      100.0      100.0       52.6        0.0        0.0        0.0        0.0        0.0
 5.30997E-05*        100.0      100.0      100.0      100.0        0.0        0.0        0.0        0.0        0.0        0.0
 6.85211E-05*        100.0      100.0      100.0      100.0        0.0        0.0        0.0        0.0        0.0        0.0
 8.84211E-05*        100.0      100.0      100.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.14101E-04*        100.0      100.0      100.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.47238E-04*        100.0      100.0      100.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.90000E-04*          0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 8.38451E-04*          0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 3.70000E-03*          0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 7.80000E-03*          0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 9.60000E-03*          0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
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                                                          DURATION

                    216.00     240.00     264.00     288.00     312.00     336.00     672.00    1008.00    1344.00    2688.00
CONCENTRATION---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
 0.00000E-01*     100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0
 1.00000E-09*      88.0       80.0       81.9       81.9       74.9       74.9       74.9       55.8        0.0        0.0
 1.57042E-09*      88.2       88.2       82.3       75.3       75.3       75.3       75.3       56.1        0.0        0.0
 2.46621E-09*      88.6       88.6       82.6       75.8       75.8       75.8       75.8       56.5        0.0        0.0
 3.87298E-09*      88.9       83.0       83.0       76.3       76.3       76.3       76.3       56.8        0.0        0.0
 6.08220E-09*      89.2       83.4       83.4       76.7       76.7       76.7       76.7       57.2        0.0        0.0
 9.55159E-09*      83.4       77.6       77.6       77.6       77.6       77.6       77.6       32.3        0.0        0.0
 1.50000E-08*      84.6       78.9       78.9       78.9       78.9       78.9       78.9       32.9        0.0        0.0
 1.91333E-08*      79.6       79.6       79.6       79.6       79.6       79.6       79.6       33.2        0.0        0.0
 2.44056E-08*      80.5       80.5       80.5       80.5       80.5       80.5       80.5       33.6        0.0        0.0
 3.11307E-08*      81.8       81.8       81.8       81.8       81.8       81.8       81.8       34.2        0.0        0.0
 3.97089E-08*      82.7       82.7       82.7       82.7       82.7       82.7       82.7       34.6        0.0        0.0
 5.06509E-08*      83.8       83.8       83.8       83.8       83.8       83.8       83.8       35.1        0.0        0.0
 6.46080E-08*      85.5       85.5       85.5       85.5       85.5       85.5       85.5       35.8        0.0        0.0
 8.24110E-08*      86.3       86.3       86.3       86.3       86.3       86.3       86.3       36.2        0.0        0.0
 1.05120E-07*      87.4       87.4       87.4       87.4       87.4       87.4       87.4       36.7        0.0        0.0
 1.34086E-07*      79.7       71.0       71.0       71.0       71.0       71.0       71.0       40.3        0.0        0.0
 1.71035E-07*      75.1       75.1       75.1       75.1       75.1       75.1       75.1       42.8        0.0        0.0
 2.18160E-07*      78.5       78.5       78.5       78.5       78.5       78.5       78.5       44.8        0.0        0.0
 2.78281E-07*      76.6       76.6       76.6       76.6       76.6       76.6       46.5        0.0        0.0        0.0
 3.54963E-07*      81.8       81.8       81.8       81.8       81.8       81.8       49.9        0.0        0.0        0.0
 4.52774E-07*      86.1       86.1       86.1       86.1       86.1       86.1       52.7        0.0        0.0        0.0
 5.77539E-07*      75.7       75.7       75.7       75.7       75.7       75.7       48.3        0.0        0.0        0.0
 7.36683E-07*      51.6       51.6       51.6       51.6       26.1        0.0        0.0        0.0        0.0        0.0
 9.39681E-07*      54.4       54.4       54.4       54.4        0.0        0.0        0.0        0.0        0.0        0.0
 1.19862E-06*      56.3       56.3       56.3       56.3        0.0        0.0        0.0        0.0        0.0        0.0
 1.52890E-06*      58.4       58.4       58.4        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.95020E-06*      31.6       31.6       31.6        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 2.48759E-06*      33.9       33.9       33.9        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 3.17306E-06*      36.0       36.0       36.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 4.04741E-06*      38.1       38.1        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 5.16270E-06*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 6.58531E-06*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 8.40000E-06*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.15000E-05*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.48399E-05*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.91497E-05*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 2.47113E-05*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 3.18880E-05*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 4.11490E-05*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 5.30997E-05*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 6.85211E-05*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 8.84211E-05*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.14101E-04*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.47238E-04*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 1.90000E-04*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 8.38451E-04*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 3.70000E-03*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 7.80000E-03*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 9.60000E-03*       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
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            PERCENTAGE OF TOTAL TIME PERIOD EVENTS WITH DURATIONS OF D(J) OR
            GREATER OCCUR FOR EVENTS DEFINED BY CONCENTRATIONS C(I) OR GREATER
                                        DURATION

                    0.50      12.00     24.00     48.00     72.00     96.00    120.00    144.00    168.00    192.00
CONCENTRATION---------- --------- --------- --------- --------- --------- --------- --------- --------- ---------
  0.00000E-01*     100.0     100.0     100.0     100.0     100.0     100.0     100.0     100.0     100.0     100.0
  1.00000E-09*      16.2      16.2      16.2      16.2      16.2      16.2      15.0      15.0      15.0      15.0
  1.57042E-09*      16.1      16.1      16.1      16.1      16.1      15.4      14.9      14.9      14.9      14.2
  2.46621E-09*      15.9      15.9      15.9      15.9      15.9      15.2      14.8      14.8      14.8      14.1
  3.87298E-09*      15.7      15.7      15.7      15.7      15.7      15.1      14.7      14.7      14.7      14.0
  6.08220E-09*      15.5      15.5      15.5      15.5      15.3      15.0      14.5      14.5      14.5      13.9
  9.55159E-09*      15.3      15.3      15.3      15.3      14.8      13.8      13.4      13.4      13.4      12.7
  1.50000E-08*      14.9      14.9      14.9      14.8      13.8      13.5      12.6      12.6      12.6      12.6
  1.91333E-08*      14.7      14.7      14.7      14.4      13.7      13.4      12.6      12.6      12.6      12.6
  2.44056E-08*      14.5      14.5      14.4      14.1      13.6      13.0      11.7      11.7      11.7      11.7
  3.11307E-08*      14.2      14.2      14.2      13.9      13.5      12.9      11.6      11.6      11.6      11.6
  3.97089E-08*      14.0      14.0      14.0      13.8      13.1      12.8      11.6      11.6      11.6      11.6
  5.06509E-08*      13.8      13.8      13.6      13.4      13.0      12.3      11.5      11.5      11.5      11.5
  6.46000E-08*      13.4      13.4      13.4      13.1      12.6      11.9      11.5      11.5      11.5      11.5
  8.24110E-08*      13.2      13.2      13.2      13.0      12.5      11.8      11.4      11.4      11.4      11.4
  1.05120E-07*      13.0      13.0      13.0      12.6      12.4      11.7      11.4      11.4      11.4      11.4
  1.34086E-07*      10.4      10.4      10.4      10.1       9.1       9.1       8.3       8.3       8.3       8.3
  1.71035E-07*       9.7       9.7       9.6       9.0       8.5       8.5       8.1       8.1       8.1       8.1
  2.18160E-07*       9.1       9.1       9.1       8.8       8.4       8.4       8.0       8.0       8.0       8.0
  2.78281E-07*       8.2       8.2       8.2       7.5       7.3       6.7       6.3       6.3       6.3       6.3
  3.54963E-07*       7.5       7.5       7.5       7.1       6.8       6.5       6.2       6.2       6.2       6.2
  4.52774E-07*       7.1       7.0       7.0       6.9       6.5       6.1       6.1       6.1       6.1       6.1
  5.77539E-07*       6.6       6.5       6.5       6.3       6.1       5.5       5.5       5.0       5.0       5.0
  7.36683E-07*       4.7       4.7       4.6       4.6       3.9       3.6       3.1       3.1       3.1       2.4
  9.39681E-07*       4.3       4.3       4.3       4.1       3.7       3.0       3.0       3.0       3.0       2.3
  1.19862E-06*       4.0       4.0       4.0       3.7       3.6       2.9       2.9       2.9       2.3       2.3
  1.52890E-06*       3.8       3.8       3.7       3.4       3.2       2.8       2.8       2.8       2.2       2.2
  1.95020E-06*       3.4       3.4       3.4       3.2       2.8       2.4       2.4       2.4       1.9       1.9
  2.48759E-06*       3.1       3.1       3.1       3.1       2.7       2.4       2.4       2.4       1.8       1.1
  3.17306E-06*       2.9       2.9       2.9       2.6       2.3       2.3       2.3       1.7       1.7       1.0
  4.04741E-06*       2.7       2.7       2.7       2.4       2.2       2.2       2.2       1.7       1.0       1.0
  5.16270E-06*       2.1       2.1       2.1       1.9       1.9       1.9       1.9       0.8       0.8       0.8
  6.58531E-06*       1.4       1.4       1.4       1.3       1.3       1.3       1.3       0.8       0.8       0.8
  8.40000E-06*       1.2       1.2       1.2       1.2       1.2       1.2       0.8       0.8       0.8       0.8
  1.15000E-05*       1.2       1.2       1.2       1.2       1.2       1.2       0.7       0.7       0.7       0.0
  1.48399E-05*       1.1       1.1       1.1       1.1       1.1       1.1       0.7       0.7       0.7       0.0
  1.91497E-05*       1.0       1.0       1.0       1.0       1.0       0.7       0.7       0.7       0.7       0.0
  2.4/113E-05*       0.9       0.9       0.9       0.9       0.9       0.7       0.7       0.7       0.7       0.0
  3.18000E-05*       0.8       0.8       0.8       0.6       0.6       0.6       0.6       0.6       0.0       0.0
  4.11490E-05*       0.6       0.6       0.6       0.6       0.3       0.0       0.0       0.0       0.0       0.0
  5.30997E-05*       0.4       0.4       0.4       0.4       0.0       0.0       0.0       0.0       0.0       0.0
  6.85211E-05*       0.2       0.2       0.2       0.2       0.0       0.0       0.0       0.0       0.0       0.0
  8.84211E-05*       0.2       0.2       0.2       0.0       0.0       0.0       0.0       0.0       0.0       0.0
  1.14101E-04*       0.1       0.1       0.1       0.0       0.0       0.0       0.0       0.0       0.0       0.0
  1.47230E-04*       0.1       0.1       0.1       0.0       0.0       0.0       0.0       0.0       0.0       0.0
  1.90000E-04*       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
  8.38451E-04*       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
  3.70000E-03*       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
  7.80000E-03*       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
  9.60000E-03*       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
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                                                               DURATION

                   216.00     240.00     264.00     288.00     312.00     336.00     672.00    1008.00    1344.00    2688.00
CONCENTRATION--------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
  0.00000E-01*      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0      100.0
  1.00000E-09*       14.3       14.3       13.3       13.3       12.2       12.2       12.2        9.1        0.0        0.0
  1.57042E-09*       14.2       14.2       13.2       12.1       12.1       12.1       12.1        9.0        0.0        0.0
  2.46621E-09*       14.1       14.1       13.1       12.0       12.0       12.0       12.0        9.0        0.0        0.0
  3.87298E-09*       14.0       13.1       13.1       12.0       12.0       12.0       12.0        8.9        0.0        0.0
  6.08220E-09*       13.9       13.0       13.0       11.9       11.9       11.9       11.9        8.9        0.0        0.0
  9.55159E-09*       12.7       11.9       11.9       11.9       11.9       11.9       11.9        4.9        0.0        0.0
  1.50000E-08*       12.6       11.8       11.8       11.8       11.8       11.8       11.8        4.9        0.0        0.0
  1.91333E-08*       11.7       11.7       11.7       11.7       11.7       11.7       11.7        4.9        0.0        0.0
  2.44056E-08*       11.7       11.7       11.7       11.7       11.7       11.7       11.7        4.9        0.0        0.0
  3.11307E-08*       11.6       11.6       11.6       11.6       11.6       11.6       11.6        4.9        0.0        0.0
  3.97089E-08*       11.6       11.6       11.6       11.6       11.6       11.6       11.6        4.9        0.0        0.0
  5.06509E-08*       11.5       11.5       11.5       11.5       11.5       11.5       11.5        4.8        0.0        0.0
  6.46080E-08*       11.5       11.5       11.5       11.5       11.5       11.5       11.5        4.8        0.0        0.0
  8.24110E-08*       11.4       11.4       11.4       11.4       11.4       11.4       11.4        4.8        0.0        0.0
  1.05120E-07*       11.4       11.4       11.4       11.4       11.4       11.4       11.4        4.8        0.0        0.0
  1.34086E-07*        8.3        7.4        7.4        7.4        7.4        7.4        7.4        4.2        0.0        0.0
  1.71035E-07*        7.3        7.3        7.3        7.3        7.3        7.3        7.3        4.1        0.0        0.0
  2.18164E-07*        7.2        7.2        7.2        7.2        7.2        7.2        7.2        4.1        0.0        0.0
  2.78281E-07*        6.3        6.3        6.3        6.3        6.3        6.3        3.8        0.0        0.0        0.0
  3.54963E-07*        6.2        6.2        6.2        6.2        6.2        6.2        3.8        0.0        0.0        0.0
  4.52774E-07*        6.1        6.1        6.1        6.1        6.1        6.1        3.7        0.0        0.0        0.0
  5.77539E-07*        5.0        5.0        5.0        5.0        5.0        5.0        3.2        0.0        0.0        0.0
  7.36683E-07*        2.4        2.4        2.4        2.4        1.2        0.0        0.0        0.0        0.0        0.0
  9.39681E-07*        2.3        2.3        2.3        2.3        0.0        0.0        0.0        0.0        0.0        0.0
  1.19862E-06*        2.3        2.3        2.3        2.3        0.0        0.0        0.0        0.0        0.0        0.0
  1.52890E-06*        2.2        2.2        2.2        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.95020E-06*        1.1        1.1        1.1        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  2.48759E-06*        1.1        1.1        1.1        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  3.17306E-06*        1.0        1.0        1.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  4.04741E-06*        1.0        1.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  5.16270E-06*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  6.58531E-06*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  8.40000E-06*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.15000E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.48399E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.91497E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  2.47113E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  3.18880E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  4.11490E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  5.30997E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  6.85211E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  8.84211E-05*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.14101E-04*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.47238E-04*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  1.90000E-04*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  8.38451E-04*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  3.70000E-03*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  7.80000E-03*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
  9.60000E-03*        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
```

```
                                   GLOBAL EXCEEDANCE SUMMARY

                       LC PIECEWISE LINEAR FUNCTIONS DEFINED BY JOINT PAIRS

                                                JOINT POINTS
FUNCTION                        1              2              3              4              5              6
   1     DURATION:         5.00000E-01    2.40000E+01    4.80000E+01    9.60000E+01    1.68000E+02    3.36000E+02
         CONCENTRATION:    1.00000E-09    1.00000E-09    1.00000E-09    1.00000E-09    1.00000E-09    1.00000E-09
   2     DURATION:         5.00000E-01    2.40000E+01    4.80000E+01    9.60000E+01    1.68000E+02    3.36000E+02
         CONCENTRATION:    1.50000E-08    1.50000E-08    1.50000E-08    1.50000E-08    1.50000E-08    1.50000E-08
   3     DURATION:         2.40000E+01    2.40000E+01    4.80000E+01    9.60000E+01    1.68000E+02    3.36000E+02
         CONCENTRATION:    1.15000E-04    1.15000E-05    8.40000E-06    8.40000E-06    8.40000E-06    8.40000E-06
   4     DURATION:         5.00000E-01    2.40000E+01    4.80000E+01    9.60000E+01    9.60000E+01    3.36000E+02
         CONCENTRATION:    1.15000E-05    1.15000E-05    8.40000E-06    8.40000E-06    1.50000E-08    1.50000E-08
   5     DURATION:         5.00000E-01    2.40000E+01    4.80000E+01    9.60000E+01    1.68000E+02    3.36000E+02
         CONCENTRATION:    1.15000E-05    1.15000E-05    8.40000E-06    8.40000E-06    8.40000E-06    8.40000E-06

                  LC PIECEWISE LINEAR FUNCTIONS DEFINED BY INTERCEPT AND SLOP (A+B(DURATION))

                                                  SEGMENT
FUNCTION                        1              2              3              4              5
   1     INTERCEPT:        1.00000E-09    1.00000E-09    1.00000E-09    1.00000E-09    1.00000E-09
         SLOPE:            0.00000E-01    0.00000E-01    0.00000E-01    0.00000E-01    0.00000E-01
   2     INTERCEPT:        1.50000E-08    1.50000E-08    1.50000E-08    1.50000E-08    1.50000E-08
         SLOPE:            0.00000E-01    0.00000E-01    0.00000E-01    0.00000E-01    0.00000E-01
   3     INTERCEPT:        0.00000E-01    1.46000E-05    8.40000E-06    8.40000E-06    8.40000E-06
         SLOPE:            0.00000E-01   -1.29167E-07    0.00000E-01    0.00000E-01    0.00000E-01
   4     INTERCEPT:        1.15000E-05    1.46000E-05    8.40000E-06    0.00000E-01    1.50000E-08
         SLOPE:            0.00000E-01   -1.29167E-07    0.00000E-01    0.00000E-01    0.00000E-01
   5     INTERCEPT:        1.15000E-05    1.46000E-05    8.40000E-06    8.40000E-06    8.40000E-06
         SLOPE:            0.00000E-01   -1.29167E-07    0.00000E-01    0.00000E-01    0.00000E-01

EXCEEDANCE SUMMARY
           NUMBER    NUMBER OF TIME PLANES    DURATION WHILE      GLOBAL EXCEEDANCE
FUNCTION  OF EVENTS  GREATER THAN FUNCTION  GREATER THAN FUNCTION     (PERCENT)
   1          9              8320                 4160.0               16.23
   2         12              7656                 3828.0               14.93
   3          2               628                  314.0                1.23
   4          6              6923                 3461.5               13.50
   5          2               628                  314.0                1.23
```

```
                                         SEGMENT 7: DISSOLVED PESTICIDE (KG/M**3) RUN NO. 1

                                                    LC FUNCTION # 1

ENDING TIME STEP   LENGTH OF EVENT (HOUR)    EVENT CONCENTRATION
----------------   ----------------------    -------------------
      51264                    109.5            1.00000E-09
      40712                     98.0            1.00000E-09
      36927                   1031.0            1.00000E-09
      20937                    196.5            1.00000E-09
      20436                     96.5            1.00000E-09
      20071                    252.0            1.00000E-09
      19070                   1289.5            1.00000E-09
       2213                    290.0            1.00000E-09
       1595                    797.0            1.00000E-09

                                                    LC FUNCTION # 2

ENDING TIME STEP   LENGTH OF EVENT (HOUR)    EVENT CONCENTRATION
----------------   ----------------------    -------------------
      51264                    106.0            1.50000E-08
      40657                     66.5            1.50000E-08
      36871                    998.5            1.50000E-08
      20875                     52.0            1.50000E-08
      20733                     86.5            1.50000E-08
      20374                     54.5            1.50000E-08
      20015                    218.5            1.50000E-08
      19011                   1257.5            1.50000E-08
       2153                    117.5            1.50000E-08
       1899                     37.0            1.50000E-08
       1789                     70.0            1.50000E-08
       1535                    763.5            1.50000E-08

                                                    LC FUNCTION # 3

ENDING TIME STEP   LENGTH OF EVENT (HOUR)    EVENT CONCENTRATION
----------------   ----------------------    -------------------
      35428                    196.5            8.40000E-06
      16774                    117.5            8.40000E-06

                                                    LC FUNCTION # 4

ENDING TIME STEP   LENGTH OF EVENT (HOUR)    EVENT CONCENTRATION
----------------   ----------------------    -------------------
      51264                    106.0            1.50000E-08
      36871                    998.5            1.50000E-08
      20015                    218.5            1.50000E-08
      19011                   1257.5            1.50000E-08
       2153                    117.5            1.50000E-08
       1535                    763.5            1.50000E-08

                                                    LC FUNCTION # 5

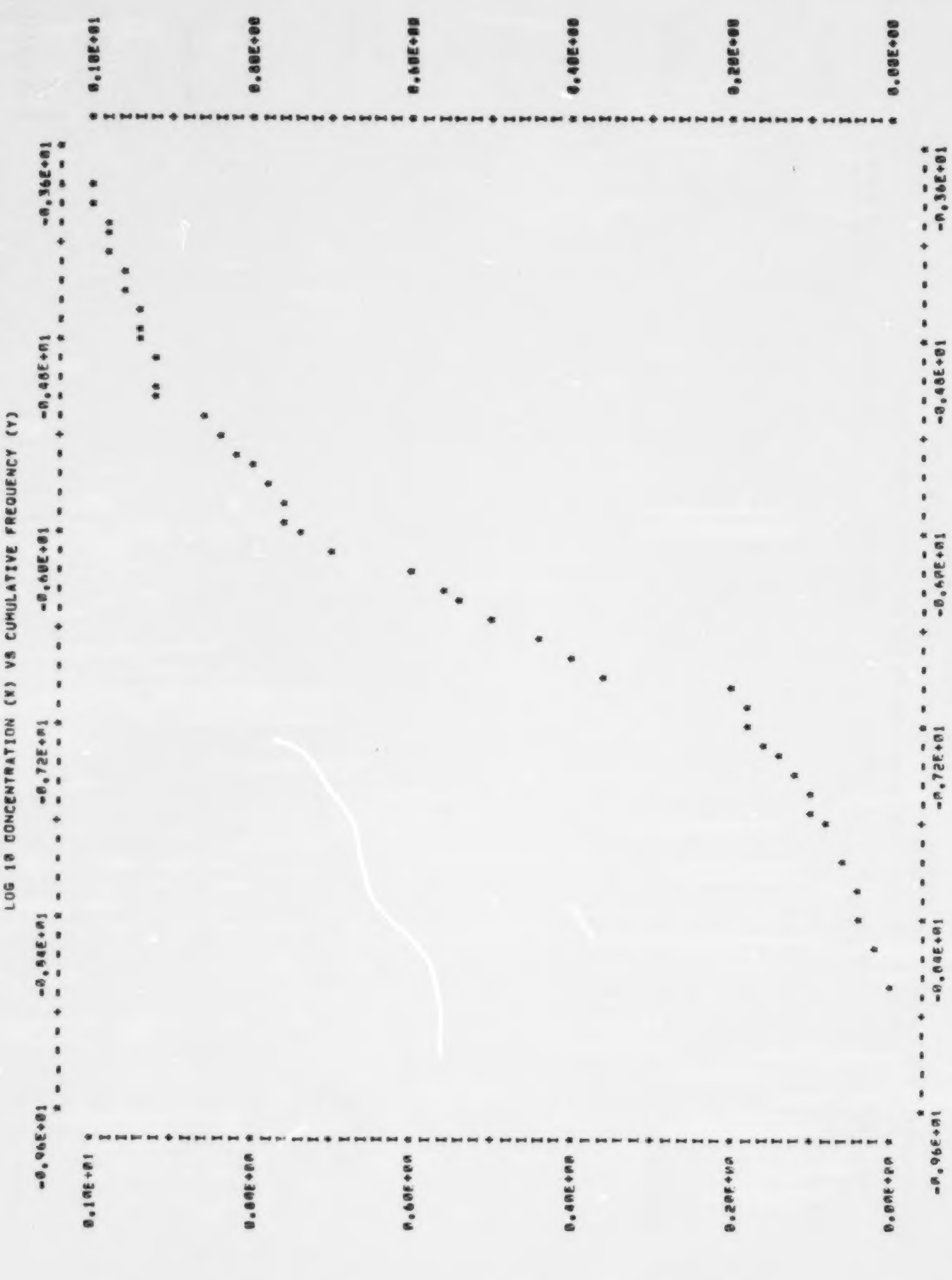
ENDING TIME STEP   LENGTH OF EVENT (HOUR)    EVENT CONCENTRATION
----------------   ----------------------    -------------------
      35428                    196.5            8.40000E-06
      16774                    117.5            8.40000E-06
```

```
                                  CONCENTRATION DISTRIBUTION SUMMARY AND ANALYSIS

                              # TIME    PERCENT      PERCENT                              EXPECTED NUMBER OF TIME STEPS
                     #EVENTS  STEPS    TOTAL TIME   TOTAL TIME  NO. TIME STEPS                 C(I) <= C <= C(I+1)
CONCENTRATION C(I)  C>=C(I)  C>=C(I)   C>=C(I)      C<C(I)    C(I)<=C<C(I+1)      NORMAL        LOG NORMAL        GAMMA
------------- ----  -------  -------  ----------  ----------  --------------  -------------  -------------  -------------
 1.00000E-09   2         9     8320      16.23       83.77              82     3.27647E+03    6.66003E+01    7.35031E+02
 1.57842E-09   3         9     8230      16.07       83.93              88     1.59660E-01    4.64559E+01    9.56496E+01
 2.46621E-09   4         9     8150      15.90       84.10              92     2.50732E-01    7.21136E+01    1.08012E+02
 3.87298E-09   5         9     8058      15.72       84.28              93     3.93555E-01    1.07578E+02    1.22034E+02
 6.00220E-09   6         9     7965      15.54       84.46             137     6.17676E-01    1.54227E+02    1.37867E+02
 9.55159E-09   7        11     7828      15.27       84.73             172     9.70459E-01    2.12489E+02    1.55741E+02
 1.50000E-08   8        12     7656      14.93       85.07              98     7.36328E-01    1.42574E+02    9.21929E+01
 1.91333E-08   9        12     7558      14.74       85.26             120     9.38965E-01    1.64020E+02    9.84448E+01
 2.44056E-08  10        13     7438      14.51       85.49             142     1.19824E+00    1.86518E+02    1.05112E+02
 3.11307E-08  11        12     7296      14.23       85.77             107     1.52856E+00    2.09659E+02    1.12220E+02
 3.97089E-08  12        12     7189      14.02       85.98             129     1.94995E+00    2.32955E+02    1.19795E+02
 5.06509E-08  13        12     7060      13.77       86.23             169     2.48755E+00    2.55858E+02    1.27861E+02
 6.46080E-08  14        10     6891      13.44       86.56             106     3.17383E+00    2.77776E+02    1.36443E+02
 8.24110E-08  15        10     6785      13.24       86.76             122     4.04980E+00    2.98094E+02    1.45564E+02
 1.05120E-07  16        10     6663      13.00       87.00            1310     5.16748E+00    3.16215E+02    1.55244E+02
 1.34086E-07  17        13     5353      10.44       89.56             404     6.59473E+00    3.31573E+02    1.65497E+02
 1.71035E-07  18        11     4949       9.65       90.35             265     8.41699E+00    3.43669E+02    1.76328E+02
 2.18164E-07  19        10     4684       9.14       90.86             481     1.07446E+01    3.52102E+02    1.87732E+02
 2.78281E-07  20        11     4203       8.20       91.80             344     1.37185E+01    3.56586E+02    2.00107E+02
 3.54963E-07  21        10     3859       7.53       92.47             232     1.75198E+01    3.56967E+02    2.12433E+02
 4.52774E-07  22         8     3627       7.08       92.92             255     2.23813E+01    3.53233E+02    2.25491E+02
 5.77539E-07  23         9     3372       6.58       93.42             956     2.86023E+01    3.45509E+02    2.38943E+02
 7.36683E-07  24         9     2416       4.71       95.29             289     3.65676E+01    3.34060E+02    2.52633E+02
 9.39681E-07  25         8     2207       4.31       95.69             131     4.67737E+01    3.19267E+02    2.66351E+02
 1.19862E-06  26         8     2076       4.05       95.95             127     5.98599E+01    3.01616E+02    2.79777E+02
 1.52890E-06  27         8     1949       3.80       96.20             199     7.66465E+01    2.81659E+02    2.93082E+02
 1.95020E-06  28         8     1750       3.41       96.59             150     9.81026E+01    2.59989E+02    3.04484E+02
 2.48759E-06  29         7     1600       3.12       96.88             124     1.25785E+02    2.37224E+02    3.14290E+02
 3.17306E-06  30         6     1476       2.88       97.12             113     1.61070E+02    2.13956E+02    3.21307E+02
 4.04741E-06  31         6     1363       2.66       97.34             270     2.05907E+02    1.90748E+02    3.25210E+02
 5.16270E-06  32         5     1093       2.13       97.87             390     2.62212E+02    1.68097E+02    3.23295E+02
 6.58531E-06  33         3      703       1.37       98.63              75     3.31359E+02    1.46436E+02    3.15051E+02
 8.40000E-06  34         2      628       1.23       98.77              33     5.49206E+02    1.59135E+02    3.03076E+02
 1.15000E-05  35         2      595       1.16       98.84              32     5.53397E+02    1.06623E+02    2.81323E+02
 1.48399E-05  36         2      563       1.10       98.90              34     6.32484E+02    8.86809E+01    2.43792E+02
 1.91497E-05  37         2      529       1.03       98.97              45     6.53400E+02    7.27061E+01    1.98760E+02
 2.47113E-05  38         2      484       0.94       99.06              95     5.68221E+02    5.89053E+01    1.49782E+02
 3.18880E-05  39         2      389       0.76       99.24              96     3.70333E+02    4.71196E+01    1.02096E+02
 4.11490E-05  40         2      293       0.57       99.43              66     1.50332E+02    3.72160E+01    6.09814E+01
 5.30997E-05  41         2      227       0.44       99.56             119     2.85459E+01    2.90225E+01    3.09678E+01
 6.85211E-05  42         1      108       0.21       99.79              15     1.63281E+00    2.23477E+01    1.20332E+01
 8.84211E-05  43         1       93       0.18       99.82              18     1.36719E-02    1.69902E+01    4.46680E+00
 1.14101E-04  44         1       75       0.15       99.85              23     0.00000E-01    1.27529E+01    9.57031E-01
 1.47238E-04  45         1       52       0.10       99.90              52     0.00000E-01    9.45312E+00    1.38812E-01
 1.90000E-04  46         0        0       0.00      100.00               0     0.00000E-01    2.07578E+01    1.07422E-02
 8.38451E-04  47         0        0       0.00      100.00               0     0.00000E-01    2.35254E+00    0.00000E-01
 3.70000E-03  48         0        0       0.00      100.00               0     0.00000E-01    1.41602E-01    0.00000E-01
 7.60000E-03  49         0        0       0.00      100.00               0     0.00000E-01    1.46484E-02    0.00000E-01
 9.60000E-03  50         0        0       0.00      100.00               0     0.00000E-01    2.73437E-02    0.00000E-01
```

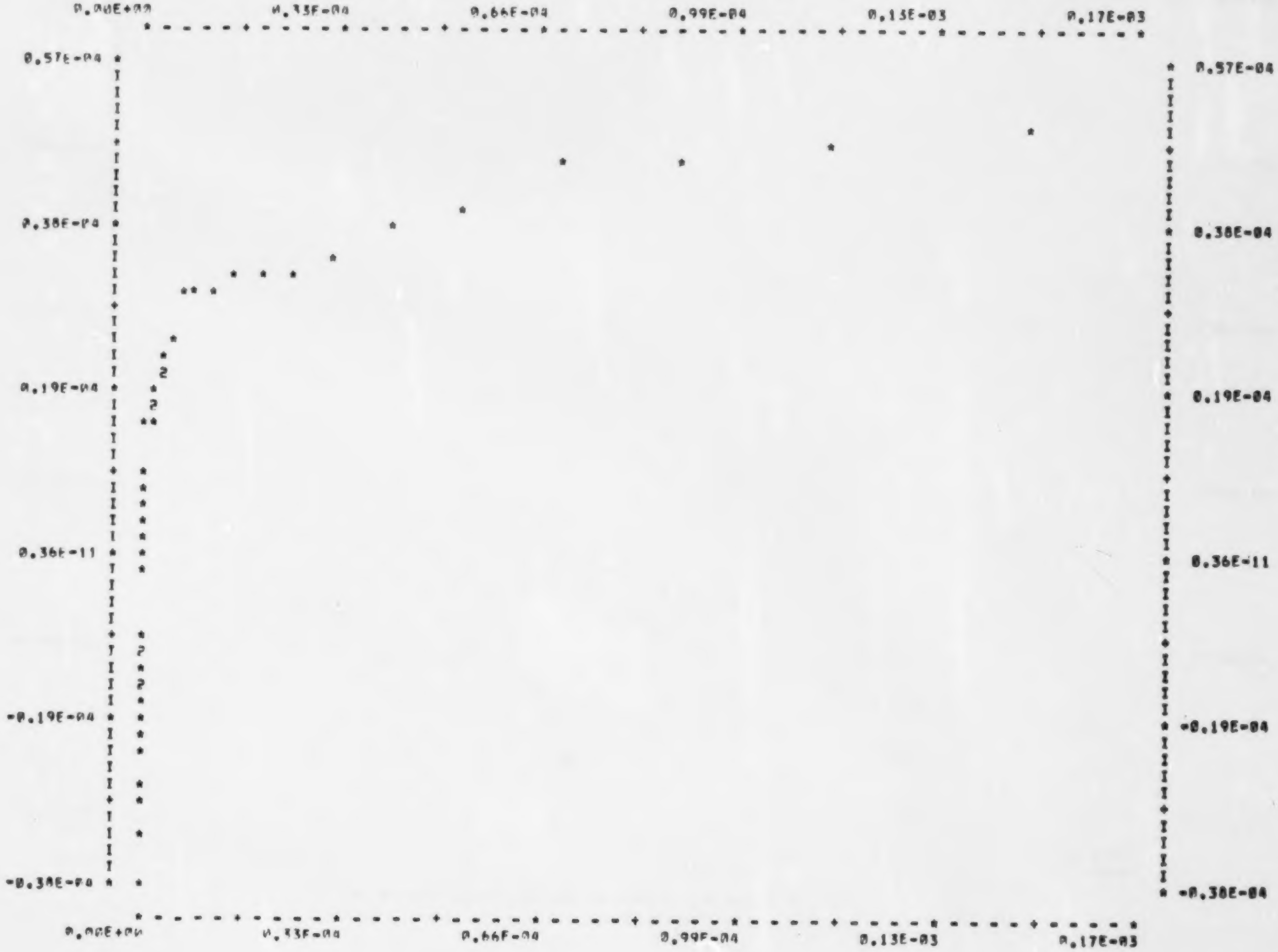
```
    SUMMARY STATISTICS
                              MEAN        STANDARD DEVIATION
                         -------------    ------------------
  ARITHMETIC              4.84393E-06         1.79738E-05
  ARITHMETIC (LOG C)     -1.48288E+01         2.25977E+00
  GEOMETRIC               3.63012E-07         9.58087E+00


  CHI SQUARE GOODNESS OF FIT
        DISTRIBUTION                  PARAMETER ESTIMATES          TEST STATISTICS     PROBABILITY OF EXCEEDING  DEGREES OF FREEDOM
        ------------           -----------------------------       ---------------     ------------------------  ------------------
  NORMAL (MEAN, STD DEV)         4.84393E-06    1.79738E-05              81746.5                       0.000          33.
  LOG NORMAL (MEAN, STD DEV)    -1.48288E+01    2.25977E+00                682.6                       0.000          43.
  GAMMA (ALPHA, BETA)            2.70636E-01    5.58710E+04               2139.2                       0.000          40.
```

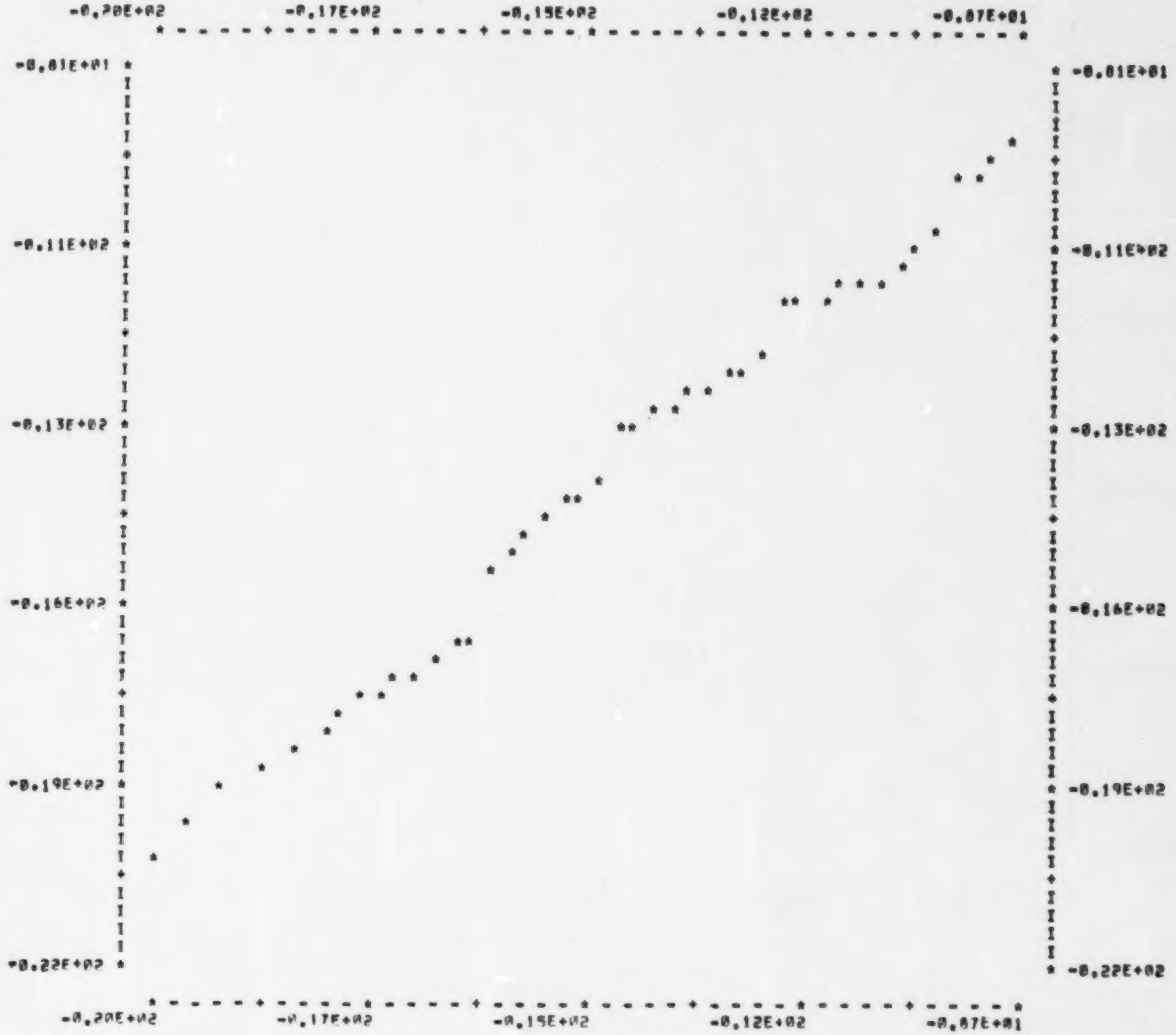


LOG 10 CONCENTRATION (X) VS CUMULATIVE FREQUENCY (Y)

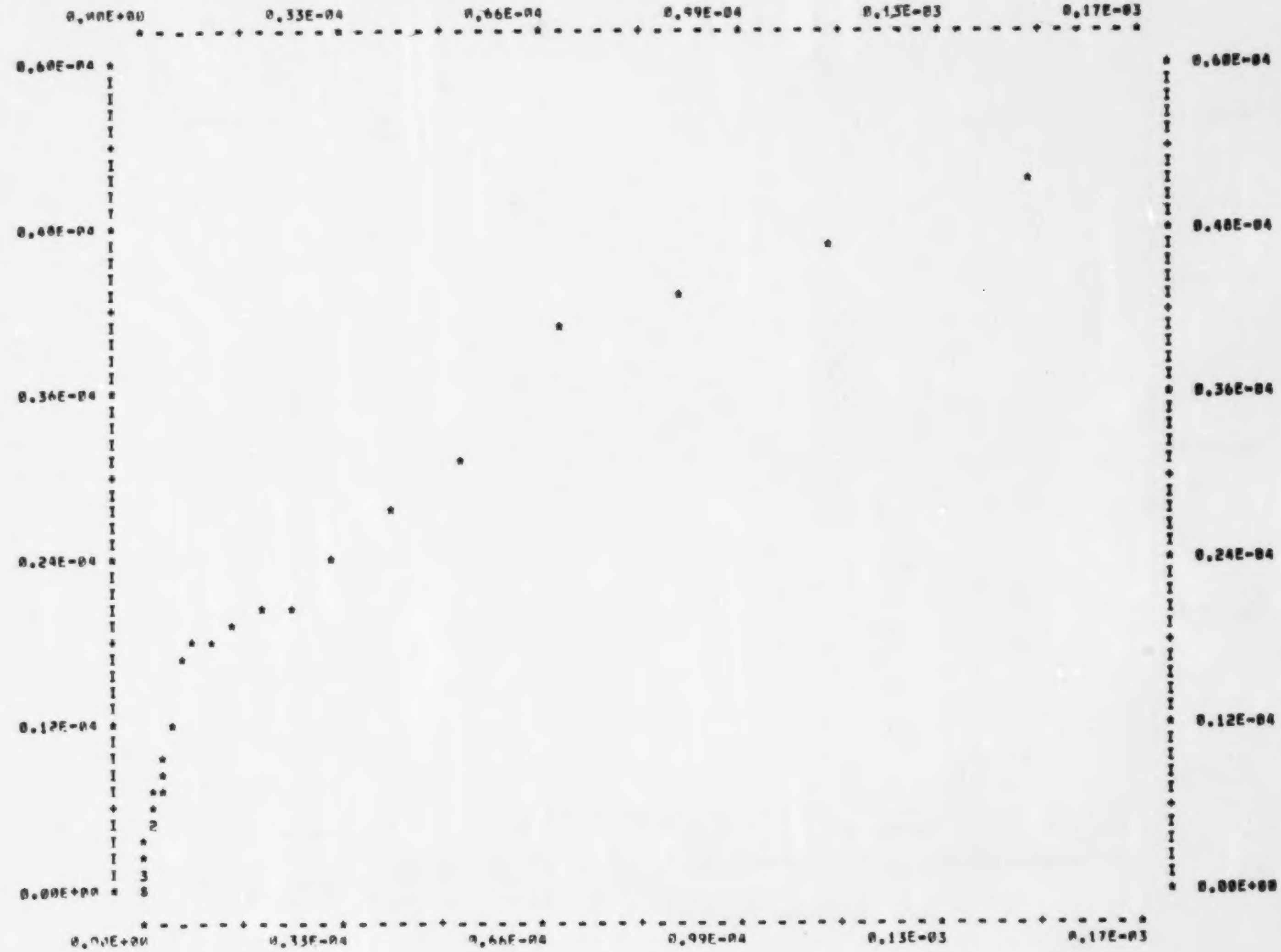
```
                                         NORMAL PROBABILITY PLOT
                                OBSERVED CONCENTRATION (X) VS NORMAL QUANTILE (Y)
QQPLOT   X-AXIS ORDERED DATA   VS   Y-AXIS -
                   EXPECTED NORMAL WITH MEAN=  4.8439338E-06 AND STD DEV =  1.7973833E-05
```



```
                                          LOG NORMAL PROBABILITY PLOT
   LOG OBSERVED CONCENTRATION (X) VS NORMAL QUANTILE (Y)
QQPLOT   X-AXIS LOG(ORDERED DATA)    VS    Y-AXIS -
                        EXPECTED NORMAL WITH MEAN= -1.4828831E+01 AND STD DEV =  2.2597687E+00
```



```
                                                GAMMA PROBABILITY PLOT
                                  OBSERVED CONCENTRATION (X) VS GAMMA QUANTILE (Y)
QQPLOT   X-AXIS ORDERED DATA   VS   Y-AXIS -
                    EXPECTED GAMMA WITH ALPHA =   0.2706,   AND BETA =  5.5871043E+04
```



SECTION 5

REFERENCES

1. Onishi, Y., S. M. Brown, A. R. Olsen, M. A. Parkhurst, S. E. Wise and W. H. Walters. 1979. "Methodology for Overland and Instream Migration and Risk Assessment of Pesticides." Battelle, Pacific Northwest Laboratories, Richland, WA.

2. Hann, C. T. 1977. Statistical Methods in Hydrology. Iowa State University Press, Ames, IA.

APPENDIX A

FRANCO USER'S GUIDE

FRANCO Operating Instructions

FRANCO is activated by typing the MCR command

```
MCR RUN FRANCO <ALT MODE >
```

and after it is loaded from the disk it announces itself and asks for the control file specification.

```
+++++ FREQUENCY ANALYSIS PROGRAM +++++

ENTER THE NAME OF THE CONTROL FILE
```

The operator must respond with the name of the control file that has been prepared for the analysis that is to be run. A proper response would be:

```
DPL:SEG2P253.CNL
```

FRANCO Control File Input Requirements

What follows is the description of the data that is required for a FRANCO analysis. The explanation of each data consists of:

1) the data set number
2) the data set title
3) a short description of the data included in the set and any precautions that must be taken.
4) the general format of each record in the set and the number of each record that will be read.
5) a breakdown of each field of the records that include the position in the record, the variable's name and the description of the values the variable may be assigned.

The order of the data sets is implied by the set's number. The order of the sets is as follows:

Data Set Number	Title
1	Analysis Title
2	Data Source Specification
3	Time Specifications
4	Control Options
5	Specified Concentrations
6	Specified Durations
7	LC-50 Piecewise Linear Functions

Data Set 1 - ANALYSIS TITLE

This record is used to title and identify each analysis.

Format: 80A1

Columns	Variable	Description
1-80	TITLE	80 columns of alphanumeric information used to title the output.

Example:

RIVER MILE 5: TOTAL PESTICIDE (KG/M**3)

Data Set 2 - DATA SOURCE SPECIFICATION

FRANCO will analyze the time series output of both the agricultural overland runoff model ARM and the instream transport model SERATRA, but it must be told which set of results is being analyzed. This data set specifies the input file name, the source of the file and the field within the data file to be analyzed.

Columns	Variable	Description
1-7	Source	Source of the time series to be analyzed = ARM; data are the results of an ARM simulation = "SERATRA"; data are the results of SERATRA simulation.
9-12	JFIELD	Both models write more than one type of data out to the time series result files and this variable points to the data within the output to be analyzed. If SOURCE = "ARM" and JFIELD = 1; Discharge (m^3/sec) = 2; Sediment (kg/min) = 3; Sediment (g/1) = 4; Dissolved pesticide (g/min)

Columns	Variable	Description
		= 5; Dissolved pesticide (ppm) = 6; Particulate pesticide (g/min) = 7; Particulate pesticide (ppm).
		If SOURCE = "SERATRA" and JFIELD = 1; Discharge (m^3/sec) = 2; Average sediment concentration (kg/m^3) = 3; Average dissolved contaminant (kg/m^3 or pc/m^3) = 4; Average particulate contaminant (kg/m^3 or pc/m^3) = 5; Average particulate contaminant (kg/kg or pc/kg) = 6; Total contaminant (kg/m^3 or pc/m^3)

Columns	Variable	Description
9-38	INPFIL	File name description of the time series analysis file containing the data to be analyzed. The time series file from the ARM model is formatted FRANCO expects the record layout to be as follows:

Format: I10, I6, 1X, I4, 7F8.3

Column	Contents
1-10	Time plane number of record
11-16	Calendar time of the plane (YRMODY)
17	Not used
18-21	Clock time of time plane (HRMN)
22-29	Discharge (m^3/sec)
30-37	Sediment (kg/min)
38-45	Sediment (g/l)
46-53	Dissolved pesticide (g/min)
54-61	Dissolved pesticide (ppm)
62-69	Particulate pesticide (g/min)
70-77	Particulate pesticide (ppm)

The SERATRA file is unformatted and the order of the variables in each record should be as follows:

Field #	Contents
1	River segment number
2	Time plane number
3	Discharge (m^3/sec)
4	Average sediment concentration (kg/m^3)

Field #	Contents
5	Average dissolved contaminant (kg/m^3 or pc/m^3)
6	Average particulate contaminant (kg/m^3 or pc/m^3)
7	Average particulate contaminant (kg/kg or pc/kg)
8	Total contaminant (kg/m^3 or pc/m^3)

Example:

```
← A →← B →← C

ARM ^ ^ ^ ^ ^5 DPO:ARM 7174.T1M
```

In the above sample, the time series file is the result of an

A) ARM model analysis and the
B) 5th output parameter, dissolved particulate concentration (ppm) is to be analyzed from the file
C) DPO:ARM7174.T1M.

Data Set 3 - TIME SPECIFICATIONS

The user is not restricted to analyzing the complete time series file as it was written by the simulation model. This data set is used to specify the time span that is to be included in the analysis. There are two different record formats and FRANCO chooses between the two based upon the value input as SOURCE.

Record type 1 used when SOURCE = "ARM" - Format: 2I5, F10.0, 6A1

Columns	Variable	Description
1-5	BTP	Starting time plane number of the analysis.
6-10	ETP	Ending time plane number of the analysis.
11-20	DELT	Size of the time step taken during the ARM simulation.
21-26	TUNIT	Time step units. = "DAY"; units of DELT is days = "HOUR"; units of DELT is hours = "MINUTE"; units of DELT is minutes

Record type 2 used when SOURCE = "SERATRA" - Format: 2I10, I5, F10.0, 6A1

Columns	Variable	Description
1-10	BTP	Starting time plane number of the analysis.
11-20	ETP	Ending time plane number of the analysis.
21-25	BSEG	Number of the river segment to be analyzed.
26-35	DELT	Size of the time step taken during the SERATRA simulation.
36-41	TUNIT	Time step units. = "DAY"; units of DELT is days = "HOUR"; units of DELT is hours = "MINUTE"; units of DELT is minutes

Example #1

```
← A → ← B → ← C    → ←  D →
^^^10^^425^^^^^^^15.0 MINUTE
```

The example above would be appropriate when analyzing the time series file from an ARM simulation. The starting time step is to be number

A) 10, the ending time step is
B) 425, and the length of each time step during the ARM simulation was
C) 15.0
D) MINUTE

Example #2

```
←   A    → ←   B    ← →C → ←  D    → ← E →
^^^^^^^^^^^1^^^^^^51264^^^7^^^^^^^^^0.5 HOURS
```

The second sample would be used with a SERATRA result file. The beginning time step is

A) 1, the last time step of the analysis is
B) 51264, and the river segment being analyzed is number
C) 7. the length of the time step during the SERATRA simulation are
D) 0.5
E) HOURS.

Data Set 4 - CONTROL OPTIONS

The data on this record and used to signal FRANCO to use either the raw data or the natural log of the data. They also specify the method that will be used to input the concentrations and durations.

Format: L1,2I5

Columns	Variable	Description
1	LOGC	= T; FRANCO will use the natural log of the data during the analysis. = F; the raw data will be used during analysis.
2-6	OPTC	Control variable that signals the method chosen to input the specified concentrations. = 1; concentrations will be specified explicitly. = 2; concentrations are input using a minimum value, a maximum value and an interval. = 3; concentrations are input by specifying a maximum of four ranges with a separate interval between each range.
7-11	OPTD	Control variable that signals the method chosen to input the specified durations. The possible values and meanings are the same as described for OPTC.

Example:

```
A ← B → ← C →
T^^^^1^^^^2
```

In the above sample the user has asked FRANCO to use

A) the natural log of the data during analysis. The specified concentrations will be input using method
B) 1 and the durations will be input using method number
C) 2.

Data Set 5 - SPECIFIED CONCENTRATIONS

The user has the option of using one of three methods when inputting the specified concentration values. Options 2 and 3 are designed to ease input burden.

Method 1 (OPTC=1) - Each concentration value is entered explicitly.

Record type 1 - Format: I5

Columns	Variable	Description
1-5	NC	Number of specified concentrations (25 maximum)

Record type 2 - Format: 8F10.0; Repeated as often as necessary to input NC values.

Columns	Variable	Description
1-10	C(J)	jth specified concentration
11-20	C(J+1)	J+1 specified concentration
21-30	C(J+2)	J+2 specified concentration
71-80	C(J+7)	J+7 specified concentration

Example:

```
← A →
^^^19

←      B →←   C    →←   D    →←    E    →←   F  →←    G    →←    H  →←
^^^^^^^0.0^^^^^^0.02^^^^^^0.05^^^^^^0.13^^^^^^0.14^^^^^^0.16^^^^^^0.19

    I   →
^^^^^0.23
```

Above is a partial example of the method 1 type of input in which

A) 19 specified concentrations are to be input. The first eight values are as follows:
B) C(1) = 0.0
C) C(2) = 0.02
D) C(3) = 0.05
E) C(4) = 0.13
F) C(5) = 0.14
G) C(6) = 0.16
H) C(7) = 0.19
I) C(8) = 0.23

Method 2 (OPTC = 2) - Concentrations are input as a minimum value, maximum value and an interval. FRANCO computes the concentrations between the minimum and maximum values.

Format: 3F10.0

Columns	Variable	Description
1-10	VMIN	Minimum concentration
11-20	VMAX	Maximum concentration
21-30	VINTVL	Interval between concentration values.

FRANCO will use this information to calculate NC values. NC is computed as NC=(VMAX-VMIN)/VINTVL+ 1 and the user must remember that NC must not be greater than 25. Also, VMAX-VMIN should be evenly divisable by VINTVL.

Example:

```
← A      →←   B    →← C   →
^^^^^^10.0^^^^^^20.0^^^^^^2.5
```

In the above sample, the minimum value is

A) 10.0, the maximum value is
B) 20.0, and the interval is
C) 2.5. This will result in the following 5 concentrations:

1) C(I) = VMIN = 10.0
2) C(2) = VMIN + VINTVL = 12.5
3) C(3) = VMIN + 2*VINTVL = 15.0
4) C(4) = VMIN + 3*VINTVL = 17.5
5) C(5) = VMIN + 4*VINTVL = VMAX = 20.0

Method 3 (OPTC=3) - This method is used to input a set of ranges and the numbers of values to be computed between each range. The user is currently allowed to split the concentration values into a maximum of four uneven intervals. The maximum number of concentrations is 25.

Record 1 - Format: I5,F10.0

Columns	Variable	Description
1-5	NS(J)	Number of values to be computed between VALS(J-1)
6-15	VALS(J)	Maximum value for this interval and the minimum value of the next interval (if there is one).

Because concentration values can vary over orders of magnitude, concentrations between the ranges are calculated using the natural log of the values. Experience has shown that this produces values that more closely match the clustering of events into the smaller concentrations found in the ARM and SERATRA results.

Example:

```
← A →←    B    →
^^^^3^^^^^^^^^0.0

← C →←   D   →
^^^0^^^^^1.0E-4

← E →←   F    →
^^^^7^^^^^1.0E-2

← G →←   H    →
^^^^4^^^^^2.0E-2
```

The sample above will produce the following concentrations

C(1) = 0.0
C(2) = 1.0000E-4
C(3) = 1.7783E-4

C(4) = 3.1623E-4
C(5) = 5.6234E-4
C(6) = 9.9999E-4
C(7) = 1.7783E-3
C(8) = 3.1623E-3
C(9) = 5.6234E-3
C(10)= 1.0000E-2
C(11)= 1.1487E-2
C(12)= 1.3195E-2
C(13)= 1.5157E-2
C(14)= 1.7411E-2
C(15)= 2.0000E-2

Data Set 6 - SPECIFIED DURATIONS

The same three methods for inputting concentrations are available for inputting specified durations. However, there is one major difference in computing durations with method 3 (OPTD=3). Durations between the ranges are calculated using a linear interpolation rather than a log interpolation. This and the fact that durations are expressed in units of time are the only differences. Therefore, refer to the section describing Data Set 5 when preparing the input for specified durations.

Data Set 7 - LC50 PIECEWISE LINEAR FUNCTIONS

This data set is used to describe the LC50 curves that are to be included in the analysis. The endpoint pair of concentration, duration values is input for each of the line segments that make up the curve. FRANCO uses this information to compute the slope and intercept of each line segment.

Record type 1 - Format: 2I5

Columns	Variable	Description
1-5	NLC	Number of LC50 piecewise functions to be used during the analysis ($0 \le \text{NLC} \le 5$).
6-10	NPT	Number of points that will be used to describe each function. All NLC functions must have the same number of concentration duration pairs. (Maximum of 6)

Record type 2 - Format 8F10.0; this type can have 1 or 2 records depending upon the value of NPT and it must be repeated for each curve being input. Of course, if NLC=0, this record type would not be included.

First record

Columns	Variable	Description
1-10	CF(I,1)	Concentration value of first pair for function I.
11-20	DF(I,1)	Duration value of first pair for function I.
21-30	CF(I,2)	Concentration value of second pair for function I.
31-40	DF(I,2)	Duration value of second pair for function I.
41-50	CF(I,3)	Concentration value of third pair for function I.
51-60	DF(I,3)	Duration value of third pair for function I.
61-70	CF(I,4)	Concentration value of fourth pair for function I.
71-80	DF(I,4)	Duration value of fourth pair for function I.

Second record - Used only if NPT>4

Columns	Variable	Description
1-10	CF(I,5)	Concentration value of fifth pair for function I.
11-20	DF(I,5)	Duration value of fifth pair for function I.
21-30	CF(I,6)	Concentration value of sixth pair for function I.
31-40	DF(I,6)	Duration value of sixth pair for function I.

Example:

```
← A →← B →
^^^^1^^^^6

←   C   →←   D  →←  E   →←   F  →←  G   →←  H   →←   I  →←  J →
^^^^^^^3.5^^^^^ 5.0^^^^^^^2.5 ^^^^^^5.0^^^^^^^2.5^^^^^^^17.5^^^^^1.5^^^^^^20.0

←   K   →←   L   →←    M    →←   N →
^^^^^^^^^1.0^^^^^^^^27.5 ^^^^^^^^^1.5 ^^^^^^^100.
```

The above sample conveys the following information:

A) 1 LC-50 piecewise linear function will be included in the analysis and it will be described using
B) 6 pairs of concentration, duration values. Those 6 pairs are
C,D) 3.5, 5.0
E,F) 2.5, 5.0
G,H) 2.5, 17.5
I,J) 1.5, 20.0
K,L) 1.0, 27.5
M,N) 1.5, 100.0

FRANCO Run Time Errors

There are three run time error messages that will be written on the terminal device where FRANCO was activated. Two will terminate the analysis. The first error message is as follows:

***** FRANCO -- ANALYSIS TERMINATED BECAUSE THE DATA WAS EXHAUSTED WITHOUT ENCOUNTERING THE STARTING TIME PLANE. CHECK YOUR INPUT.

This message will be printed whenever an end-of-file is encountered while searching the source file (Data Set 2) for the beginning time plane. The two major reasons for this message are (1) invalid starting time plane (Data Set 3) or (2) the wrong source file was specified (Data Set 2).

The second message will occur under similar circumstances as the first.

***** FRANCO -- ANALYSIS TERMINATED BECAUSE THE REQUESTED RIVER SEGMENT COULD NOT BE FOUND.

This means that while searching a time series analysis result file from SERATRA for the requested river segment, an end-of-file was encountered. Examine the river segment number (Data Set 3) and the data file specification (Data Set 2) for possible mistakes.

The final message that can be printed is associated with the processing of the control file. When an error or data inconsistency is detected in the control file, the following message will appear.

*****FRANCO -- ERROR ENCOUNTERED DURING INPUT PROCESSING. EXAMINE LINE PRINTER LISTING FOR AN EXPLANATION.

As FRANCO processes the control file, all input and calculated values are enchoed to the line printer. Whenever possible, error messages will appear directly beneath the input values that caused the error.

Below is the list of error messages that can be produced during processing. They are self-explanatory and no further explanation will be furnished. Those errors that will suspend further input processing are marked with an "F" for fatal.

STARTING TIME IS LATER THAN THE ENDING TIME

F - INVALID VALUE FOR THE SPECIFIED CONCENTRATION INPUT CONTROL VARIABLE - OPTC
F - INVALID VALUE FOR THE SPECIFIED DURATION INPUT CONTROL VARIABLE - OPTD
F - INVALID NUMBER OF LC PIECEWISE LINEAR FUNCTIONS XX MAXIMUM ALLOWED
F - INVALID NUMBER OF LC PIECEWISE LINEAR FUNCTION PAIRS (MUST BE AT LEAST 3 AND NO MORE THAN XX)

APPENDIX B

FRANCO PROGRAM MODULE DESCRIPTIONS

The modules that are described in this section include the executive program FRANCO, numerous subroutines and one INCLUDE file that contains the array dimensions and other limits. Each description will include a narrative explanation and any links to and from the subprograms. Because of their nature, some of the routines will be considered as "black boxes" and very little information will be supplied.

Executive Program - FRANCO

FRANCO does very few computations. Its main responsibilities are to read the time analysis data, control the flow of data through the proper subroutines, and oversee the printing of the results.

The basic steps of an analysis are as follows:

1) Learn the name of the control file and open it.
2) Call the subroutine FACINP to read the control file.
3) Determine the number of time steps in each specified duration.
4) Open the time series analysis file and search through the file to find the river segment to be analyzed and the starting time plane.
5) Call subroutine PIECE to compute the intercept and slopes of each of the LC50 curves.
6) Open the temporary files needed for the LC50 analysis.
7) Process all of the time steps to be included in the analysis. This step includes:

    a) reading the next record in the file and filling in the gaps left by any missing time planes,
    b) calling subroutine EVENT which will increment the proper event counters and marking the LC50 curves, and
    c) calling subroutine SUMSAT which accumulates partial sums and other counts.

8) Close off the analysis by counting the events caused by using a concentration that is the difference of the first two specified concentrations.
9) Print the event occurrence reports.
10) Call subroutine FRAC to compute and print the event percentage occurrence reports.

11) Call subroutine LCFINI to finish the LC50 analysis and to print the results.
12) Call subroutine CDAS to compute and print the concentration distribution summary analysis.
13) Call subroutine PLTSUM to plot the frequency plot, and the normal, log normal and gamma distribution plots.

Calls subprograms FACINP, PIECE, EVENT, SUMSAT, MATPRT, FRAC, LCFINI, CDAS, and PLTSUM.

Figure B.1 is a graphical representation of the module linkages in FRANCO. All of the linkages are shown so there is a certain amount of duplication that is not reflected in the program's overlay descriptor.

Subroutine CDAS

Responsible for conducting the concentration distribution summary and analysis computations for all events with a non-zero concentration. It also prints the results of the analysis. The items that are computed include various means and standard deviations, chi square goodness of fit tests, various probabilities, the expected observations of each concentration and many others.

Called by FRANCO.
Calls subroutines GAMML, NORCUM, GAMCUM.

Subroutine CROSS

General purpose two dimensional line printer plotting routine.
Called by PLTSUM, QQPLOT
Calls subprograms EVICT, SORTP, and PSCALE

Subroutine EVENT

Counts the events and the time planes in the events that have concentrations greater than or equal to each of the specified concentrations and a duration that is greater than or equal to the specified durations.
Called by FRANCO.
Calls subprograms LCCONT and LCPREP.

Function EVICT

Range checks the values being plotted by subroutine CROSS.
Called by CROSS.

Subroutine FACINP

Supervises the reading of the control input file and reads a majority of the data itself.
Called by FRANCO.
Call subprograms OPT1, OPT2, and OPT3.

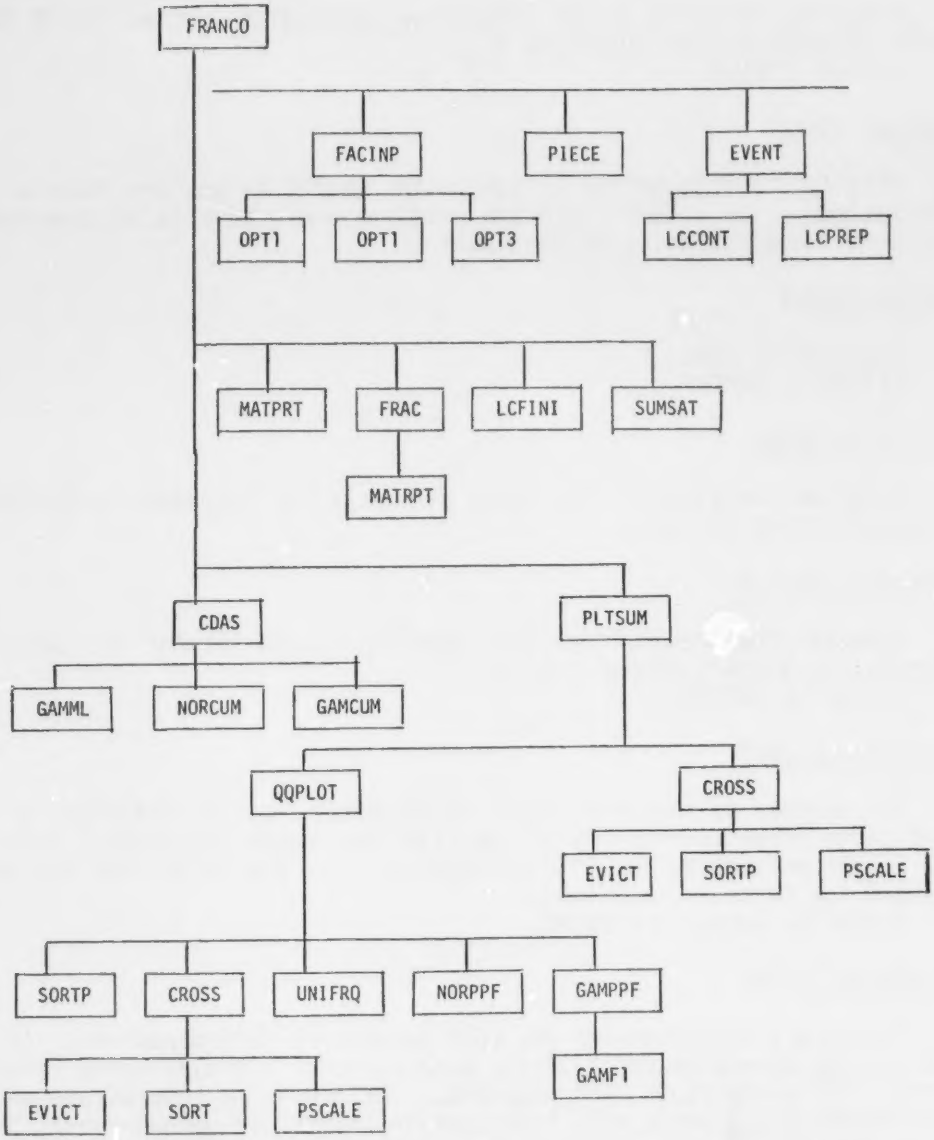

FRANCO
FACINP
PIECE
EVENT
OPT1
OPT1
OPT3
LCCONT
LCPREP
MATPRT
FRAC
LCFINI
SUMSAT
MATRPT
CDAS
PLTSUM
GAMML
NORCUM
GAMCUM
QQPLOT
CROSS
EVICT
SORTP
PSCALE
SORTP
CROSS
UNIFRQ
NORPPF
GAMPPF
GAMF1
EVICT
SORT
PSCALE

Figure B.1. FRANCO module linkages.

Subroutine FRAC

Computes the percentage of occurrence values and causes them to be printed.
Called by FRANCO.
Calls subprogram MATPRT.

Subroutine GAMCUM

Computes the value of the cumulative gamma distribution P with the limits of intergration from 0 to X.
Called by CDAS.

Function GAMFNI

This function is called by subroutine GAMPPF to perform interim calculations. The code of both the routines would have to be examined to gain a full understanding of the routine.

Function GAMLN

Computes $\ln \Gamma(A)$.
Called by GAMPPF.

Subroutine GAMML

Computes the maximum likelihood estimates for the gamma distribution parameters alpha and beta.

Subroutine GAMPPF

Computes the probability point function (quantile) for the gamma distribution given a probability p.
Called by QQPLOT.

Subroutine LCCONT

The purpose of this routine is to determine if the conditions of the event cause exceedance of any of the LC50 continuous functions. Those that do are written to the file corresponding to the curve that has been exceeded for further processing.
Called by subroutine EVENT.

Subroutine LCFINI

This subroutine finishes the LC50 exceedance determinations. It examines the direct access file for each function and eliminates those records that would cause double counts. The remaining records are written to permanent files which will then contain only those unique events that exceed the LC50 curve. It also prints a summary of each file.
Called by FRANCO.

Subroutine LCPREP

The purpose of this routine is to determine if the conditions of the event cause exceedance of any of the LC50 piecewise linear functions. Those that qualify are written to the file corresponding to the exceeded curve for further processing.

Called by subroutine EVENT.

Subroutine MATPRT

This routine is responsible for printing tables containing either real or integer values under a predefined format.

Called by FRANCO and FRAC.

Subroutine NORCUM

Computes the cumulative (from minus infinity to X) probability P for the normal distribution with a mean AMEAN and standard deviation SIGMA.

Called by CDAS.

Subroutine NORPPF

Computes the percent point function (quantile) for the normal distribution with a mean of AMEAN and standard deviation SIGMA given a probability P.

Called by QQPLOT.

Subroutine OPT1

Responsible for reading the explicit specified concentrations and durations.

Called by FACINP.

Subroutine OPT2

Reads the specified concentrations and durations when the user has elected to input them as a lower and upper limit and an interval. Also computes the interval values.

Called by FACINP.

Subroutine OPT3

Called upon to read concentration and duration data that is to be specified as a set of ranges and the number of values to be included in each range. Also computes the values with the ranges.

Called by FACINP.

Subroutine PIECE

The purpose of this routine is to construct a preset number of piecewise linear functions given the point pairs that describe the function. Returns the slope and intercept of each line segment.

Called by FRANCO.

Subroutine PLTSUM

Oversees the production of three line printer plots: base 10 log of concentrations versus cumulative, observed concentration versus normal quantile and observed concentration versus gamma quantile.

Called by FRANCO.

Calls CROSS and QQPLOT.

Subroutine PSCALE

Routine selects the scale for the line printer plots produced by subroutine CROSS.

Called by CROSS.

Subroutine QQPLOT

Makes a line printer plot of the data in the array X versus percent point probability data (quantiles) obtained from the subroutine PPF.

Called by PLTSUM.

Calls UNIFRQ and PPF which is the name of the subroutine passed by the calling routine. In the FRANCO application only routines NORPPF and GAMPPF.

Subroutine SORTP

This routine sorts the elements of the input vector X and puts the sorted elements into the vector Y. It also carries along the index of the original position of each element in X.

Called by CROSS, QQPLOT.

Subroutine SUMSAT

Responsible for accumulating partial sums and means that will become part of the summary statistics.

Called by FRANCO.

Subroutine UNIFRQ

This routine is used by the probability plotting routine to obtain the distributional quantiles. It computes an approximation to the median of the NCI(I) order statistic from a uniform distribution.

Called by QQPLOT.

Include File FRANCO.PRM

This file contains the parameters that control the maximum number of specified concentrations and duration, the maximum number of LC50 curves, the maximum number of points in each curve and the line printer logical unit number.

Any changes to the parameters will necessitate recompiling the program modules and rebuilding of the task image. It may also be necessary to construct a new overlay description file.

Variable Descriptions

Listed below, in alphabetical order, are the brief descriptions of the more important variables from FRANCO. Each description contains the variable names, type and explanation.

Name	Type	Explanation
A(NLCF,NLCP)	R*4	Slopes of each line segment of the LC50 piecewise linear curves.
AA(4,NLCF)	R*4	Four constants that describe the LC50 continuous functions.
AMEAN(2)	R*4	Arithmetic mean holding array.
ASD(2)	R*4	Arithmetic standard deviation holding array.
ASUMS(2)	R*4	Arithmetic sum of squares holding array.
B(NLCF,NLCP)	R*4	Intercept of each line segment of each LC50 piecewise linear curves.
BSEG	I*2	Number of the river segment to be analyzed.
BTP	I*4	Starting time plane number of the analysis.
C(JC)	R*4	Specified concentrations.
CF(NLCF,NLCP)	R*4	Concentration values of the LC50 piecewise linear functions.
CNTFIL(30)	BYTE	Holding array for the control input file name.
CONC(7)	BYTE	Concentration values read from the time series analysis input data file.
CURTP	I*4	Number of the time plane being processed.

Name	Type	Explanation
D(JD)	R*4	Specified durations.
DELT	R*4	Time step size.
DF(NLCF,NLCP)	R*4	Duration values of the LC50 piecewise linear functions.
ETP	I*4	Last time plane to be analyzed.
GMEAN(2)	R*4	Geometric mean holding array.
GSD(2)	R*4	Geometric standard deviation holding array.
IER	I*2	Input error flag.
INPFIL(30)	BYTE	Holding array for the time series analysis input file.
JFIELD	I*2	Pointer to the concentration value being analyzed.
JC	I*2	Maximum number of specified concentrations.
JD	I*2	Maximum number of specified durations.
JMIS	I*4	Missing time plane number.
LMEAN(2)	R*4	Log mean holding array.
LOGC	L*1	Flag indicating whether or not the summary statistics will be done with the natural log of the concentrations.
LSD(2)	R*4	Log standard deviations.
LSUMS(2)	R*4	Log sum of squares.
LUN(NLCF)	I*2	Logical unit number of each LC50 file.
MD	I*2	Number of specified durations to be used during the analysis.
MISTP	I*4	Missing time step number.
NC	I*2	Number of specified concentrations to be used during the analysis.
NCLC	I*2	Number of LC50 continuous functions.

Name	Type	Explanation
ND(JD)	I*2	Number of time steps in each of the specified durations.
NDC(JC)	I*4	Event counter that is incremented each time the input concentration is greater than a specified concentration.
NE(JC,JD)	I*2	Event counter matrix.
NLC	I*2	Number of LC50 piecewise linear functions.
NLCF	I*2	Maximum number of LC50 curves.
NLCP	I*2	Maximum number of points in each LC50 curve.
NDT	I*2	Number of concentration duration pairs that is being used to describe the LC50 piecewise linear functions.
NREC(NLCF)	I*2	Record counter for the LC50 temporary files.
NT(JC,JD)	I*4	Time plane counter matrix.
NTIM	I*4	Current time plane number.
NXEQ	I*4	Time plane number.
P(JC,JD)	R*4	Scratch pad array used to hold calculated percentages.
PRVTP	I*4	Previous time plane.
SOURCE(7)	BYTE	Name of the model that produced the concentrations being analyzed.
W(2,2)	R*4	Count of the number of sums in LMEAN and AMEAN.

FRANCO Data Files

The data file manipulation of FRANCO is very straightforward. In addition to the control file and the file containing the time series data, there are two sets of files that are used in the LC50 analysis.

Each condition that exceeds an LC50 curve is written to the direct access file corresponding to the curve that was exceeded. Then after all the time planes have been analyzed, these files are read in reverse order and conditions that would cause duplicate counts of exceedance are ignored and those that remain are written to the permanent file (such as LCISAVE.RLT). The permanent file can be used for further analysis.

APPENDIX C

FRANCO SOURCE LISTING

FRANCO computer source listings are present in FLECS compatible code. Some subroutines are entirely in FORTRAN compatible source and may be used as direct input to a FORTRAN computer. FLECS routines must be preprocessed by a FLECS compiler which produces FORTRAN source.

The typing of variables is consistent with DEC PDP 11 and VAX 11 software systems. In particular BYTE refers to a single character word length.

FRANCO is not given in portable code but it should be relatively simple to transport it to other operating systems that have FLECS or Fortran 77 capabilities. Originally, FRANCO was designed to operate on a PDP 11/45 with 28K words of core available. The code must be overlaid to achieve this. Execution times for most applications are less than 5 minutes CPU time.

```
        --------------------------------------

C      (101,5)FRANCO.FLX
C
C   PROGRAM FRANCO
C      FREQUENCY ANALYSIS OF CONCENTRATION
C      --          --            --
C
C      PURPOSE IS TO SUMMARIZE A SINGLE TIME SERIES OF CONCENTRATIONS
C      USING THE CONCEPT OF EVENT AND DURATION.  THE TIME SERIES IS
C      OPERATED ON A SINGLE RECORD AT A TIME SO THAT ANY LENGTH OF
C      SERIES MAY BE HANDLED.  OUTPUT CONSISTS OF PRINTED FREQUENCY
C      DISTRIBUTIONS IN TABULAR FORM.   AND LINE PRINTER PLOTS. LC-50
C      INFO IS SAVED FOR FUTURE ANALYSIS.
C
      INCLUDE 'SY:FRANCO.PRM'
C
      BYTE CNTFIL(30),INPFIL(30),SOURCE(7),HEAD1(80),HEAD2(80),
     1     HEAD3(80),HEAD4(80)
C
      INTEGER*2 BBEG
C
      INTEGER*4 BTP,ETP,CURTP,NXEQ,NTIM,
     1          PRVTP,MISTP,JMIS,NT(JC,JD),NDC(JC)
C
      LOGICAL*1 DONE,EOF,LOGC
C
      REAL LSUMS(2),LMEAN(2),LSD(2)
C
      DIMENSION C(JC),D(JD),CF(NLCF,NLCP),DF(NLCF,NLCP),NE(JC,JD),
     1          ND(JD),LUN(NLCF),NREC(NLCF),
     2          A(NLCF,NLCP),B(NLCF,NLCP),CONC(7),AMEAN(2),ASUMS(2),
     3          GMEAN(2),ASD(2),GSD(2),W(2,2),AA(4,NLCF),P(JC,JD)
C
      DATA EOF /.FALSE./
      DATA LOGC /.FALSE./
      DATA LUN /2,3,4,5,6/      !AS NLCF CHANGES SO MUST LUN
      DATA NREC /5*1/
      DATA NE /JCJD*0/
      DATA NT /JCJD*0/
      DATA NDC /JC*0/
      DATA ND /JD*0/
      DATA CURTP/0/
      DATA AMEAN,ASUMS,W,LMEAN,LSUMS /12*0/
      DATA HEAD1/13*' ','N','U','M','B','E','R',' ','O','F',
     1 ' ','E','V','E','N','T','S',' ','W','I','T',
     2 'H',' ','A',' ','D','U','R','A','T','I','O','N',
     3 ' ','O','F',' ','D','(','J',')',' ','O','R',' ',
     4 'G','R','E','A','T','E','R',16*' '/
      DATA HEAD2/8*' ','G','I','V','E','N',' ','T','H','A','T',' ',
     1 'T','H','E',' ','E','V','E','N','T',' ','I','S',
     2 ' ','D','E','F','I','N','E','D',' ','B','Y',' ','C',
     3 'O','N','C','E','N','T','R','A','T','I','O','N',
     4 'S',' ','C','(','I',')',' ','O','R',' ','G','R',
     5 'E','A','T','E','R',7*' '/
```

```
       DATA HEAD3/9*' ','N','U','M','B','E','R',' ','O','F',' ','T',
      1 'I','M','E',' ','P','L','A','N','E','S',' ',
      2 'W','I','T','H',' ','D','U','R','A',
      3 'T','I','O','N','S',' ','O','F',' ','D','(','J',
      4 ')',' ','O','R',' ','G','R','E','A','T','E','R',
      5 ' ','O','C','C','U','R',11*' '/
       DATA HEAD4/8*' ','G','I','V','E','N',' ','T','H','A','T',' ',
      1 'T','H','E',' ','E','V','E','N','T',' ','I','S',
      2 ' ','D','E','F','I','N','E','D',' ','B','Y',
      3 'C','O','N','C','E','N','T','R','A','T','I','O',
      4 'N','S',' ','C','(','I',')',' ','O','R',' ','G',
      5 'R','E','A','T','E','R',8*' '/
C
       WRITE(1,1)
1      FORMAT(10X,'***** FREQUENCY ANALYSIS PROGRAM *****'//
      1 '$ENTER THE NAME OF THE CONTROL FILE>')
       READ(1,2) NCHR,(CNTFIL(I),I=1,28)
2      FORMAT(Q,30A1)
       CNTFIL(NCHR+1) = 0
       CLOSE(UNIT=1)
C
       CALL ASNLUN(1,'DP',0)
       OPEN(UNIT=1,NAME=CNTFIL,TYPE='OLD',READONLY)
C
       CALL FACINP(BBEG,BTP,C,CF,D,DELT,DF,
      1            ETP,IER,INPFIL,JFIELD,MD,NC,NLC,NPT,SOURCE,
      2            NCLC,AA,LOGC)
C
       CLOSE(UNIT=1)
       IF (IER .NE. 0)
       .  CALL ASNLUN(1,'TI',0)
       .  WRITE(1,3)
3      .  FORMAT(//'***** FRANCO -- ERROR ENCOUNTERED DURING INPUT',
      1.    ' PROCESSING'/' EXAMINE LINE PRINTER LISTING FOR AN',
      2.    ' EXPLANATION')
       .  STOP
       ...FIN
C
C      *** DETERMINE THE NUMBER OF TIME STEPS IN EACH DURATION ***
       DO (K=1,MD) ND(K) = D(K) / DELT
C
C      *** OPEN THE INPUT FILE AND IF NECESSARY, SKIP DATA ***
       WHEN (SOURCE(1) .EQ. 'A')
       .  OPEN(UNIT=1,NAME=INPFIL,TYPE='OLD',READONLY)
       .  REPEAT UNTIL (CURTP .GE. BTP)
       .  .  READ(1,4,END=500) CURTP
4      .  .  FORMAT(9X,I10,5F15.0)
       .  ...FIN
       .  BACKSPACE 1
       ...FIN
       ELSE
       .  OPEN(UNIT=1,NAME=INPFIL,TYPE='OLD',FORM='UNFORMATTED',READONLY)
       .  REPEAT UNTIL (IBEG .EQ. BBEG)
       .  .  READ(1,END=500) IBEG,NXEQ
       .  ...FIN
       .  UNTIL (NXEQ .GE. BTP)
```

```
           .  .  READ(1,END=500) ISEG,NXEQ
           .  ...FIN
           .  BACKSPACE 1
           ...FIN
      C
           IF (NLC .GT. 0)
           .  CALL PIECE(CF,DF,NLC,NPT,A,B)
      C    .  *** OPEN THE TEMPORARY FILES THAT ARE USED TO STORE DATA FROM
      C    .       SUBR. LCPREP ***
           .  DO (I=1,NLC+NCLC)
           .  .  OPEN(UNIT=LUN(I),TYPE='SCRATCH',ACCESS='DIRECT',
          1.  .        FORM='UNFORMATTED',RECORDSIZE=3,INITIALSIZE=10,
          2.  .        ASSOCIATEVARIABLE=NREC(I))
           .  ...FIN
           ...FIN
      C
           C2LOG = ALOG10(C(2)/2.)
           DONE = .FALSE.
           REPEAT UNTIL (DONE)
           .  READ-THE-NEXT-ENTRY
           .  CALL EVENT(NC,MD,CONC(JFIELD),C,NDC,ND,NE,NT,NTIM,DELT,
          1.              A,B,DF,NLC,NPT,NREC,LUN,NCLC,AA)
           .  WHEN (LOGC) CARG = ALOG10(CONC(JFIELD)) - C2LOG
           .  ELSE CARG = CONC(JFIELD)
           .  CALL SUMSAT(AMEAN,ASUMS,CARG,LMEAN,LSUMS,W)
       100 .  CONTINUE
           ...FIN
           CLOSE(UNIT=1)
      C    *** CLOSE OFF ALL EVENTS ***
           CZERO = C(1) - C(2)
           CALL EVENT(NC,MD,CZERO,C,NDC,ND,NE,NT,NTIM,DELT,
          1             A,B,DF,NLC,NPT,NREC,LUN,NCLC,AA)
      C
      C    *** PRINT THE NE AND NT ARRAYS ***
           CALL MATPRT(C,D,NE,NT,P,NC,MD,HEAD1,HEAD2,1)
           CALL MATPRT(C,D,NE,NT,P,NC,MD,HEAD3,HEAD4,3)
      C
      C    *** COMPUTE AND PRINT THE FRACTIONS PE, PT, PTT ***
           CALL FRAC(NE,NT,NTIM,NC,MD,P,C,D)
           IF (NLC+NCLC .GT. 0)
           .  CALL LCFINI(NREC,LUN,NLC,NTIM,CF,DF,NPT,NCLC,AA,A,B,DELT)
           ...FIN
      C
           DO (I=1,2)
           .  GMEAN(I) = EXP(LMEAN(I))
           .  ASD(I) = SQRT(ASUMS(I) / (W(I,1) - 1.0))
           .  LSD(I) = SQRT(LSUMS(I) / (W(I,2) - 1.0))
           .  GSD(I) = EXP(LSD(I))
           ...FIN
      C
           IF (LOGC)
           .  DO (I=2,NC) C(I) = ALOG10(C(I)) - C2LOG
           ...FIN
           CALL CDAB(C,P,NE,NT,NTIM,NC,AMEAN,LMEAN,ASD,LSD,GMEAN,GSD,
          1            ALPHA,BETA)
      C
```

```
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 00166          CALL PLTSUM(C,NT,NC,NTIM,AMEAN,LMEAN,ASD,LSD,ALPHA,BETA)
 00167          STOP
 00168    C
 00169    200   CONTINUE
 00170    C     *** FILL TO THE END WITH ZEROS ***
 00171          MISTP = ETP - PRVTP
 00172          FILL-MISTP-TIME-STEPS-WITH-ZEROS
 00173          DONE = .TRUE.
 00174          GO TO 100
 00175    C
 00176    500   CONTINUE
 00177          CLOSE(UNIT=1)
 00178          CALL ASNLUN(1,'TI',0)
 00179          WRITE(1,5)
 00180    5     FORMAT(//' ***** FRANCO -- ANALYSIS TERMINATED BECAUSE THE DATA',
 00181         1 ' WAS EXHAUSTED WITHOUT'/' ENCOUNTERING THE STARTING DATE.',
 00182         2 ' CHECK YOUR INPUT.')
 00183          STOP
 00184    C

          ----------------------------------------

 00185          TO READ-THE-NEXT-ENTRY
 00186          .  PRVTP = CURTP
 00187          .  WHEN (SOURCE(1) .EQ. 'A') READ(1,4,END=200) CURTP,(CONC(I),I=1,5)
 00188          .  ELSE READ(1,END=200) ISEG,CURTP,(CONC(I),I=1,6)
 00189          .  WHEN (CURTP .GE. ETP) DONE = .TRUE.
 00190          .  ELSE
 00191          .  .  MISTP = CURTP - PRVTP - 1
 00192          .  .  IF (MISTP .GT. 0) FILL-MISTP-TIME-STEPS-WITH-ZEROS
 00193          .  ...FIN
 00194          .  NTIM = NTIM + 1
 00195          ...FIN

          ----------------------------------------

 00196          TO FILL-MISTP-TIME-STEPS-WITH-ZEROS
 00197          .  DO (JMIS=1,MISTP)
 00198          .  .  NTIM = NTIM + 1
 00199          .  .  CALL EVENT(NC,MD,0,0,C,NDC,ND,NE,NT,NTIM,DELT,A,B,DF,NLC,
 00200         1.  .              NPT,NREC,LUN,NCLC,AA)
 00201          .  .  CALL SUMSAT(AMEAN,ASUMS,0,0,LMEAN,LSUMS,W)
 00202          .  ...FIN
 00203          ...FIN
 00204    C
 00205          END

          ----------------------------------------

                PROCEDURE CROSS-REFERENCE TABLE

          00196 FILL-MISTP-TIME-STEPS-WITH-ZEROS
                00172  00192

          00185 READ-THE-NEXT-ENTRY
                00129
          ----------------------------------------

          SUBROUTINE CDAS(C,P,NE,NT,NTIM,NC,AMEAN,LMEAN,ASD,LSD,GMEAN,GSD,
     1                    ALPHA,BETA)
C
C    CONCENTRATION DISTRIBUTION SUMMARY AND ANALYSIS ROUTINE
C
      INCLUDE 'SY:FRANCO.PRM'
C
      INTEGER*4 NT(JC,JD),NTIM,NN,NTDIF(JC),NOB,OBSN(JC)
C
      REAL LMEAN(2),LSD(2)
C
      DIMENSION ENN(JC),ENL(JC),ENG(JC),C(JC),P(JC,JD),NE(JC,JD),
     1          AMEAN(2),ASD(2),GMEAN(2),GSD(2),EXPN(JC)
C
      DATA BOTCNT / 1.0 /
C
C     *** ANALYZE ALL NON-ZERO EVENTS ***
      J = 3
      N = 2
      NN = NT(2,1)
      COMPUTE-VALUES
      PRINT-HEADING
      PRINT-TABLES
      RETURN
C
1     FORMAT(1H1,36X,'CONCENTRATION DISTRIBUTION SUMMARY AND ANALYSIS'//
     1 29X,'# TIME',4X,'PERCENT',5X,'PERCENT',26X,
     2 'EXPECTED NUMBER OF TIME STEPS'/
     3 20X,'#EVENTS   STEPS   TOTAL TIME  TOTAL TIME  NO. TIME STEPS',
     4 14X,'C(I) <= C <= C(I+1)'/1X,'CONCENTRATION C(I)  C>=C(I)',
     5 2X,'C>=C(I)   C>=C(I)',6X,'C<C(I)    C(I)<=C<C(I+1)',
     6 6X,'NORMAL',7X,'LOG NORMAL',6X,'GAMMA'/1X,13('-'),1X,'-----',
     7 2X,7('-'),2X,7('-'),2X,10('-'),2X,10('-'),2X,14('-'),
     8 2X,13('-'),2X,13('-'),2X,13('-'))
2     FORMAT(1PE13.5,2X,I2,4X,I5,4X,I5,5X,0PF6.2,6X,F6.2,9X,I5,6X,
     1 3(1PE13.5,2X))
3     FORMAT(///' CHI SQUARE GOODNESS OF FIT'
     1 /7X,'DISTRIBUTION',
     2 14X,'PARAMETER ESTIMATES',7X,'TEST STATISTICS',5X,
     3 'PROBABILITY OF EXCEEDING  DEGREES OF FREEDOM'
     4 /7X,12('-'),10X,28('-'),
     5 2X,15('-'),5X,24('-'),2X,18('-'))
4     FORMAT(1X,'ARITHMETIC',10X,1PE13.5,5X,1PE13.5)
5     FORMAT(1X,'ARITHMETIC (LOG C)',2X,1PE13.5,5X,1PE13.5)
6     FORMAT(1X,'GEOMETRIC',11X,1PE13.5,5X,1PE13.5)
7     FORMAT(1X,'NORMAL (MEAN, STD DEV)',6X,1PE13.5,2X,1PE13.5,
     1 3X,0PF13.1,11X,F13.3,10X,F5.0)
8     FORMAT(1X,'LOG NORMAL (MEAN, STD DEV)',2X,1PE13.5,2X,1PE13.5,
     1 3X,0PF13.1,11X,F13.3,10X,F5.0)
9     FORMAT(1X,'GAMMA (ALPHA, BETA)',9X,1PE13.5,2X,1PE13.5,
     1 3X,0PF13.1,11X,F13.3,10X,F5.0)
10    FORMAT(1H1///,4X,'SUMMARY STATISTICS'/
     1 25X,'MEAN',7X,'STANDARD DEVIATION'/
```

```
         2 21X,13('-'),2X,18('-'))
   C

   --------------------------------------

         TO COMPUTE-VALUES
         .  CALL GAMML(AMEAN(N),GMEAN(N),ALPHA,BETA)
         .  DO (I=J,NC)
         .  .  CALL NORCUM(C(I),AMEAN(N),ASD(N),PSUBI)
         .  .  ENN(I) = NN * PSUBI
         .  .  CLOG = ALOG(C(I))
         .  .  CALL NORCUM(CLOG,LMEAN(N),LSD(N),PSUBI)
         .  .  ENL(I) = NN * PSUBI
         .  .  CALL GAMCUM(C(I),ALPHA,BETA,PSUBI)
         .  .  ENG(I) = NN * PSUBI
         .  ...FIN
         .  ENN(J-1) = ENN(J)
         .  ENL(J-1) = ENL(J)
         .  ENG(J-1) = ENG(J)
         .  DO (I=J,NC-1)
         .  .  ENN(I) = ENN(I+1) - ENN(I)
         .  .  ENL(I) = ENL(I+1) - ENL(I)
         .  .  ENG(I) = ENG(I+1) - ENG(I)
         .  ...FIN
         .  ENN(NC) = NN - ENN(NC)
         .  ENL(NC) = NN - ENL(NC)
         .  ENG(NC) = NN - ENG(NC)
   C     .
         .  DO (I=J-1,NC-1) NTDIF(I) = NT(I,1) - NT(I+1,1)
         .  NTDIF(NC) = NT(NC,1)
         .  DO (I=J-1,NC)
         .  .  EXPN(I-J+2) = ENN(I)
         .  .  OBSN(I-J+2) = NTDIF(I)
         .  ...FIN
         .  COLLAPSE-CELLS
         .  CHIN = 0.0
         .  DO (I=1,NCELLS) CHIN = CHIN + ((OBSN(I) - EXPN(I))**2) / EXPN(I)
         .  DFN = NCELLS - 3
         .  CALL GAMCUM(CHIN,DFN/2.,.5,PCHIN)
         .  CHIN = (CHIN-DFN) / SQRT(2.*DFN)
         .  DO (I=J-1,NC)
         .  .  EXPN(I-J+2) = ENL(I)
         .  .  OBSN(I-J+2) = NTDIF(I)
         .  ...FIN
         .  COLLAPSE-CELLS
         .  CHIL = 0.0
         .  DO (I=1,NCELLS) CHIL = CHIL + ((OBSN(I) - EXPN(I))**2) / EXPN(I)
         .  DFL = NCELLS - 3
         .  CALL GAMCUM(CHIL,DFL/2.,.5,PCHIL)
         .  CHIL = (CHIL-DFL) / SQRT(2.*DFL)
         .  DO (I=J-1,NC)
         .  .  EXPN(I-J+2) = ENG (I)
         .  .  OBSN(I-J+2) = NTDIF(I)
         .  ...FIN
         .  COLLAPSE-CELLS
         .  CHIG = 0.0
```

```
           .  DO (I=1,NCELLS) CHIG = CHIG + ((OBSN(I) - EXPN(I))**2) / EXPN(I)
           .  DFG = NCELLS - 3
           .  CALL GAMCUM(CHIG,DFG/2.,.5,PCHIG)
           .  CHIG = (CHIG-DFG) / SQRT(2.*DFG)
           ...FIN

     ----------------------------------------

           TO PRINT-HEADING
           .  WRITE(LP,1)
           ...FIN

     ----------------------------------------

           TO PRINT-TABLES
           .  DO (I=J-1,NC)
           .  .  WRITE(LP,2) C(I),I,NE(I,1),NT(I,1),P(I,1),100.-P(I,1),
          1.  .   NTOIF(I),ENN(I),ENL(I),ENG(I)
           .  ...FIN
           .  WRITE(LP,10)
           .  WRITE(LP,4) AMEAN(N),ASD(N)
           .  WRITE(LP,5) LMEAN(N),LSD(N)
           .  WRITE(LP,6) GMEAN(N),GSD(N)
           .  WRITE(LP,3)
           .  WRITE(LP,7) AMEAN(N),ASD(N),CHIN,1.-PCHIN,DFN
           .  WRITE(LP,8) LMEAN(N),LSD(N),CHIL,1.-PCHIL,DFL
           .  WRITE(LP,9) ALPHA,BETA,CHIG,1.-PCHIG,DFG
           ...FIN

     ----------------------------------------

           TO COLLAPSE-CELLS
           .  K = 1
           .  NCELLS = 0
   55      .  NOB = 0.0
           .  PK = 0.0
   60      .  PK = PK + EXPN(K)
           .  NOB = NOB + OBSN(K)
           .  K = K + 1
           .  IF (K .GT. NC-J+2) GO TO 65
           .  IF (PK .LT. BOTCNT) GO TO 60
           .  NCELLS = NCELLS + 1
           .  EXPN(NCELLS) = PK
           .  OBSN(NCELLS) = NOB
           .  GO TO 55
   65      .  IF (PK .GE. BOTCNT) GO TO 70
           .  EXPN(NCELLS) = EXPN(NCELLS) + PK
           .  OBSN(NCELLS) = OBSN(NCELLS) + NOB
           .  GO TO 75
   70      .  NCELLS = NCELLS + 1
           .  EXPN(NCELLS) = PK
           .  OBSN(NCELLS) = NOB
   75      .  CONTINUE
           ...FIN
   C
           END
```

```
      ----------------------------------------
      SUBROUTINE CROSS(N,X,Y,SYM,IDUM,DUM,ISYMB)
C*********************************************************************
C
C     THIS IS A GENERAL TWO DIMENSIONAL LINE PRINTER PLOT SUBROUTINE
C         WITH THE FOLLOWING FEATURES.
C
C              DEFAULT VALUES FOR PLOTTING OPTIONS ARE USED UNLESS
C                   CHANGED BY USER AS GIVEN BELOW. ONLY CALL LIST
C                   NEED BE USED IF DEFAULT OPTION IS SELECTED
C
C     CALL LIST VARIABLES =  ALL ARRAYS DIMENSIONED NIN IN CALLING PROG.
C        N      NUMBER OF DATA POINTS IN X ARRAY
C        X      X COORDINATE ARRAY
C        Y      Y COORDINATE ARRAY
C        SYM    SYMBOL VARIABLE OR ARRAY
C         IDUM      DUMMY ARRAY FOR PLOT ROUTINE
C         DUM       DUMMY ARRAY FOR PLOT ROUTINE
C
C        ISYMB  =0 EXPECTS ONLY ONE SYMBOL - MAY DIMENSION SYM(1)
C               =1 EXPECTS ARRAY OF SYMBOLS OF LENGTH N
C     PRINTER CONTROL
C         FIRST PAGE OF PLOT DOES NOT AUTOMATICALLY START AT TOP OF NEW
C         PRINTER PAGE.  IF DESIRED, CALLING PROGRAM MAY START THE PLOT
C         AT THE TOP OF A PAGE WITH 3 LINES, (POSSIBLY HEADING,BLANK,
C         HEADING).
C
C     CROSS  WILL PLOT EITHER A 1 CHARACTER ALPHANUMERIC WORD OR
C          THE FIRST NDIGIT(LT 3) DIGITS OF A REAL WORD ALONG WITH A
C          SIGN.  NDIGIT IS THE MAXIMUM NUMBER OF DIGITS TO BE PRINTED.
C          THE DIGIT OPTION IS SPECIFIED BY ICONZ = 1.  (SYM(I),I=1,N)
C          IS USED UNDER BOTH OPTIONS.
C
C     AN OVERRIDE OF A DEFAULT OPTION IS ACCOMPLISHED BY USING BLOCK
C        COMMON STATEMENTS.  THE DEFAULT OPTIONS ARE CONTAINED IN DATA
C        STATEMENTS.  IT IS RECOMMENDED THAT ARITHMETIC STATEMENTS BE
C        USED IN USER PROGRAM TO SPECIFY OPTION PARAMETERS.  THE BLOCK
C        COMMON STATEMENTS ARE
C
C     COMMON /WINSOR/WINSOX,WINSOY,KOUNTW
C     COMMON /BASE/IXBASE,XBASE,IYBASE,YBASE
C     COMMON/IODEV/IPR,IRD
C     COMMON/SCALE/UYMIN,UYMAX,UXMIN,UXMAX
C     COMMON /CONTRL/LI,NCOL,IXAX,IYAX,ICONZ,NDIGIT,FORM
C            LI      NUMBER OF LINES FOR Y-AXIS(MULTIPLE OF 10)
C        NCOL      NUMBER OF COLS/PAGE FOR X AXIS(MULTIPLE OF 20).
C                  NCOL LESS THAN 100.
C          IXAX(IYAX)  X AXIS(Y AXIS) SCALE SELECTION
C                   =1  CROSS  SELECTS NICE SCALE
C                   =2  CROSS  SELECTS GOOD SCALE
C                   =3  CROSS  USES XX(YY) MAX AND MIN VALUES FOR SCALE
C                   =4  USER SUPPLIES MAX AND MIN VALUES
C                       UXMIN,UXMAX (UYMIN,UYMAX)
C          ICONZ =0  (DEFAULT) ALPHANUMERIC CHARACTER PRINTED
```

```
C                 *1  UP TU NDIGIT DIGITS FROM (  SYM(I),I=1,N  ) PRINTED
C            NDIGIT    SEE ABOVE
C
C      FOR A FULL DISCUSSION OF PLOT SIZE OPTIONS, SCALE SELECTION OPTION
C         DATA DELETION OPTION AND MULTIPLE DATA SET OPTIONS CONSULT
C        A.R.(TONY) OLSEN.
C
C*************************************************************************
      INCLUDE 'SY:FRANCO.PRM'
      REAL*8 FORMA,FORMB,FORMX,FORMY,FORM
      COMMON /WINSOR/WINSOX,WINSOY,KOUNTW
      COMMON /CONTRL/LI,NCOL,IXAX,IYAX,ICONZ,NDIGIT,FORM
      COMMON/SCALE/UYMIN,UYMAX,UXMIN,UXMAX
      COMMON/IODEV/IPR,IRD
      COMMON /BASE/IXBASE,XBASE,IYBASE,YBASE
       DIMENSIUN X(1),Y(1),IDUM(1),DUM(1),SYM(1)
      DIMENSION PX(6),DIGIT(10),ALF(105),NDIG(105)
      DIMENSION FORMA(5),IFOR(4),FORMX(5),FORMY(7),FORMB(3)
      LOGICAL POS,EV,EVICT
      DATA PERIOD,IXBASE,XBASE,IYBASE,YBASE/1H.,0,0,0,0,0,0/
      DATA FORMA/' 27A1',' 47A1',' 67A1',' 87A1','107A1'/
      DATA FORMX/'(6X','F9.3',',5(11X','F9.3','))'/
      DATA FORMB/'(11X,','107A1',')'/
      DATA FORMY/'(1X','F9.3',',1X,','107A1',',1X','F9.3',')'/
      DATA FORM/'F9.3'/
      DATA IFOR/'*','+','I',' '/
      DATA DIGIT/1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9/
      DATA DOLLAR,DASH,BLANK,WINSOY,WINSOX/1H$,1H-,1H ,1HW,1HW/
      DATA LI,NCOL,IXAX,IYAX/50,100,2,2/
      DATA ICONZ,NDIGIT/0,1/
 1090 FORMAT(10X,1H*,5(A1,19H- - - - + - - - - *))
 1120 FORMAT(1H0,20X,21HCONTOUR = VALUE*10**(,I3,1H))
 1300 FORMAT(1H0,10X,39HCROSS  HAD NO DATA POINTS TO PLOT - N =,I6)
 2000 FORMAT(1H1,//,7H  PAGE,I2,20H OF A PLOT REQUIRING,I3,7H PAGES.)
C
C                    LOGICAL FUNCTION EVICT IS USED TO SKIP LINES OF DATA
C                    NOT TO BE PLOTTED
C
      IPR=LP
      IF(N) 5,5,10
    5   WRITE(IPR,1300) N
      RETURN
10    XMIN=1.0E37
      ARMAX=-XMIN
      XMAX=ARMAX
      IF(ICONZ.EQ.0) GO TU 20
      DO 15 I=1,N
      EV=EVICT(X(I),Y(I))
      IF(EV) GO TO 15
      ARMAX=AMAX1(ARMAX,ABS(SYM(I)))
15    CONTINUE
      IPOW=INT(ALOG10(ARMAX)+40.)-NDIGIT-39
C
C          DETERMINE Y-AXIS SCALE FOR CROSSPLOT USING THE Y SCALE
C               SELECTION OPTION GIVEN BY IYAX
C
```

```
      20 CALL SORTP(Y,N,DUM,IDUM)
         J=N/2
         KK=N+1
         DO 25 I=1,J
         II=KK-I
         K=IDUM(I)
         IDUM(I)=IDUM(II)
      25 IDUM(II)=K
         IF(IYAX.EQ.4) GO TO 40
         DO 30  I=1,N
         II=IDUM(KK-I)
         EV=EVICT(X(II),Y(II))
         IF(EV) GO TO 30
         YMIN=Y(II)
         GO TO 35
      30 CONTINUE
      35 DO 36 I=1,N
         II=IDUM(I)
         EV=EVICT(X(II),Y(II))
         IF(FV) GO TO 36
         YMAX=Y(II)
         GO TO 37
      36 CONTINUE
      37 CONTINUE
         IF(YMIN.EQ.YMAX) YMAX=YMIN+1.
         ISCALE=IYAX
         IF(IYAX.GT.2) ISCALE=0
         GO TO 50
   40    ISCALE=0
         YMIN=UYMIN
         YMAX=UYMAX
   50    CALL PSCALE(1,ISCALE,LI,YMIN,YMAX,EXACT,YFIRST,LINES)
         LINES=LINES+2
   C
   C
   C       X-AXIS SCALE SELECTION
   C
   C
         IF(IXAX.EQ.4) GO TO 70
         DO 60 I=1,N
         EV=EVICT(X(I),Y(I))
         IF(EV) GO TO 60
         XMIN=AMIN1(XMIN,X(I))
         XMAX=AMAX1(XMAX,X(I))
   60    CONTINUE
         IF(XMIN.EQ.XMAX) XMAX=XMIN+1.
         ISCALE=IXAX
         IF(IXAX.GT.2) ISCALE=0
         GO TO 80
   70    ISCALE=0
         XMIN=UXMIN
         XMAX=UXMAX
   80    CALL PSCALE(2,ISCALE,NCOL,XMIN,XMAX,XACT,XFIRST,MCOL)
         DEX=0.5*XACT
         TENX=20.*XACT
         LEAF=(MCOL+98)/100
      MCOL=MCUL/20
C
C           SET UP OUTER PLOT LIMITS FOR WINSORIZING
C
      XUPPER=XFIRST+XACT*FLOAT(20*MCOL)+DEX
        XLOWER=XFIRST-DEX
      YLOWER=YFIRST-EXACT*(FLOAT(LINES-3)+0.5)
      YUPPER=YFIRST+EXACT*0.5
      KOUNTW=0
      FORMX(2)=FORM
      FORMX(4)=FORM
      FORMY(2)=FORM
      FORMY(6)=FORM
C
C         DETERMINE PLOTTING POSITIONS AND SETUP PLOT BY LINE THEN
C              BY PAGE.
C              X AND Y DATA POINTS OUTSIDE THE SPECIFIED PLOT RANGE
C                ARE WINSORIZED AND COUNTED.
C
      DO 700 L=1,LEAF
      M=5
      IF(5*L-MCOL.GE.0) M=MOD(MCOL-1,5)+1
      KK=M*20+5
      MM=M+1
      FORMA(2)=FORMA(M)
      FORMY(4)=FORMA(M)
      PX(1)=XFIRST+100.*XACT*FLOAT(L-1)
      DO 210 I=2,MM
  210 PX(I)=TENX*FLOAT(I-1)+PX(1)
      IF(L.NE.1) WRITE(IPR,2000) L,LEAF
      WRITE(IPR,FORMX)
      WRITE(IPR,FORMX) (PX(I),I=1,MM)
      WRITE(IPR,1090)((1H ),I=1,M)
      J=1
      JSAVE=0
      XPLOTL=PX(1)-DEX
      XPLOTU=PX(MM)+2.5*XACT
      YPLOTL=YUPPER+EXACT
      DO 600 I=1,LINES
      YPLOT=YFIRST-EXACT*FLOAT(I-2)
      YPLOTU=YPLOTL
      YPLOTL=YUPPER-EXACT*FLOAT(I-1)
      DO 500 K=1,105
      NDIG(K)=0
500   ALF(K)=BLANK
  520 IF(J-N) 523,523,550
  523 PLOTY=Y(IDUM(J))
      PLOTX=X(IDUM(J))
      EV=EVICT(PLOTX,PLOTY)
      IF(EV) GO TO 540
      ALPHA=SYM(1)
      IF(ISYMB.EQ.1) ALPHA=SYM(IDUM(J))
      IF(PLOTX-XLOWER) 541,524,524
  524 IF(PLOTX-XUPPER) 525,542,542
  525 IF(PLOTX-XPLOTL) 540,526,526
  526 IF(YUPPER-PLOTY) 543,543,527
  527 IF(PLOTY-YPLOTU) 528,528,550
  528 IF(PLOTY-YPLOTL) 550,550,529
  529 IF(YLOWER-PLOTY) 550,530,543
  530 IF(PLOTX-XPLOTU) 531,531,540
  531 CONTINUE
      KOL=INT((PLOTX-XPLOTL)/XACT + 3.0)
      IF(KOL.GT.KK) KOL=KK
      IF(KOL.LT.1 ) KOL=1
C
C          DETERMINE IF A ONE CHARACTER SYMBOL IS TO BE PLOTTED AND
C               LOAD ALF ARRAY.
C
       IF(ICONZ.EQ.1) GO TO 535
  532 IF(ALF(KOL).NE.BLANK) GO TO 533
      ALF(KOL)=ALPHA
      NDIG(KOL)=1
      GO TO 540
  533 NDIG(KOL)=NDIG(KOL)+1
      IF(NDIG(KOL).GE.10) GO TO 534
      K=NDIG(KOL)+1
      ALF(KOL)=DIGIT(K)
      GO TO 540
  534 ALF(KOL)=DOLLAR
      GO TO 540
  535 IF(ALPHA.EQ.WINSOY) GO TO 532
      IF(ALPHA.EQ.WINSOX) GO TO 532
      INTGER=INT(SYM(IDUM(J))*10.**(-IPOW))
      POS = INTGER.GE.0
      DO 536   K=1,3
      II=MOD(IABS(INTGER),10)+1
      ALPHA=DIGIT(II)
      II=KOL-K+1
      IF(ALF(II).NE.BLANK) ALPHA=DOLLAR
      ALF(II)=ALPHA
      INTGER=INTGER/10
      IF(INTGER.EQ.0) GO TO 537
  536 CONTINUE
  537 CONTINUE
      IF(POS) GO TO 540
      II=MAX0(1,II-1)
      ALPHA=DASH
      IF(ALF(II).NE.BLANK) ALPHA=DOLLAR
      ALF(II)=ALPHA
  540 J=J+1
      GO TO 520
  541 IF(L.NE.1) GO TO 540
      PLOTX=XFIRST-2.0*XACT
      ALPHA=WINSOX
      IF(JSAVE.EQ.J) GO TO 526
      JSAVE=J
      KOUNTW=KOUNTW+1
      GO TO 526
  542 IF(L.NE.LEAF) GO TO 540
      PLOTX=XUPPER+1.5*XACT
      ALPHA=WINSOX
      IF(JSAVE.EQ.J) GO TO 526
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```
              JSAVE=J
              KOUNTW=KOUNTW+1
              GO TO 526
      543     IF(ALPHA.EQ.WINSOX) GO TO 544
              KOUNTW=KOUNTW+1
      544     ALPHA=WINSOY
              GO TO 530
        550   CONTINUE
              IF(I.EQ.LINES.AND.J.LE.N) GO TO 529
      C
      C            PRINTOUT RESULTS FOR A SINGLE LINE.
      C
              IF(IXBASE.EQ.0) GO TO 553
              KOL=INT((XBASE-XPLOTL)/XACT+3.)
              IF((KOL.GT.(KK-2)).OR.(KOL.LT.3)) GO TO 553
              IF(ALF(KOL).EQ.BLANK) ALF(KOL)=PERIOD
        553   IF(IYBASE.EQ.0) GO TO 554
              IF(YBASE.GT.YPLOTU) GO TO 554
              IF(YBASE.LE.YPLOTL) GO TO 554
              K=KK-2
              DO 552 KOL=3,K,2
              IF(ALF(KOL).EQ.BLANK) ALF(KOL)=DASH
        552   CONTINUE
        554   IK=3
              IF(I.EQ.1.OR.I.EQ.LINES) IK=4
              IF(MOD(I-2,10).EQ.0) IK=1
              IF(MOD(I-2,10).EQ.5) IK=2
              IF(IK.EQ.1) GO TO 560
              WRITE(IPR,FORMB) IFOR(IK),(ALF(K),K=1,KK),IFOR(IK)
              GO TO 600
      560     WRITE(IPR,FORMY)YPLOT,IFOR(1),(ALF(K),K=1,KK),IFOR(1),YPLOT
        600   CONTINUE
              WRITE(IPR,1090)((1H ),K=1,M)
              WRITE(IPR,FORMX) (PX(K),K=1,MM)
        700   CONTINUE
              IF(ICONZ.EQ.1) WRITE(IPR,1120) IPOW
              RETURN
              END

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              SUBROUTINE EVENT(NC,MD,CONC,C,NDC,ND,NE,NT,NTIM,DELT,A,B,
             1                 DF,NLC,NPT,NREC,LUN,NCLC,AA)
        C
        C   THIS ROUTINE IS RESPONSIBLE FOR COUNTING THE EVENTS AND THE TIME
        C   PLANES IN THE EVENTS THAT HAVE CONCENTRATIONS (CONC) GREATER THAN
        C   OR EQUAL TO C(J) AND A DURATION (NDC(J)) GREATER THAN OR EQUAL
        C   TO ND(K). IT ALSO CALLS LCCONT AND LCPREP WHICH PREPARE THE SCRATCH
        C   DATA FILES FOR THE LC50 FUNCTIONS.  THIS ROUTINE IS CALLED BY THE
        C   MAIN PROGRAM FRANCO.
        C
        C      NC     - NUMBER OF CONCENTRATION LEVELS
        C      MD     - NUMBER OF DURATIONS
        C      CONC   - CONCENTRATION READ FROM THE INPUT FILE (CALCULATED)
        C      C      - CONCENTRATION LEVELS INPUT BY THE USER (SPECIFIED)
        C      NDC    - EVENT COUNTER INCREMENTED EACH TIME STEP THAT CONC .GE. C
        C      ND(K)  - NUMBER OF TIME STEPS IN DURATION K.
        C      NE     - EVENT COUNTER MATRIX
        C      NT     - TIME PLANE COUNTER MATRIX
        C      NCLC   -
        C      AA     -
        C
        C      VARIABLES NTIM THRU LUN ARE PASSED TO THIS SUBROUTINE ONLY TO
        C      PASSED TO LCCONT AND LCPREP WHERE THEY ARE ACTUALLY USED.
        C
              INCLUDE 'SY:FRANCO.PRM'
        C
              INTEGER*4 NT(JC,JD),NDC(JC)
        C
              DIMENSION C(JC),ND(JD),NE(JC,JD),
             1          DF(NLCP,NLCP),NREC(NLCP),LUN(NLCP),AA(4,NLCP),
             2          A(NLCP,NLCP),B(NLCP,NLCP)
        C
              J=NC
              REPEAT UNTIL (J.EQ.0)
              .  WHEN (CONC .GE. C(J))
              .  .  NDC(J)=NDC(J)+1
              .  ...FIN
              .  ELSE
              .  .  IF(NDC(J) .GT. 0)
              .  .  .  K=1
              .  .  .  UNTIL (K .GT. MD .OR. NDC(J) .LT. ND(K))
              .  .  .  .  NE(J,K)=NE(J,K)+1
              .  .  .  .  NT(J,K)=NT(J,K)+NDC(J)
              .  .  .  .  K=K+1
              .  .  .  ...FIN
              .  .  .  IF (NLC .GT. 0)
              .  .  .  .  CALL LCPREP(C(J),NDC(J),NTIM,DELT,A,B,DF,NLC,NPT,NREC,LUN)
              .  .  .  ...FIN
              .  .  .  IF (NCLC .GT. 0)
              .  .  .  .  CALL LCCONT(C(J),NDC(J),NTIM,DELT,AA,NCLC,NLC,NREC,LUN)
              .  .  .  ...FIN
              .  .  .  NDC(J)=0
              .  .  ...FIN
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              .  ...FIN
              .  J=J-1
              ...FIN
              RETURN
              END

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               FUNCTION EVICT(X,Y)
               LOGICAL EVICT
               COMMON/BAD/XBAD,YBAD
               DATA XBAD,YBAD/1.0E37,1.0E37/
         C
         C          TRUE MEANS EVICT
         C
               IF(X-XBAD)1,2,1
         1     IF(Y-YBAD)3,2,3
         2     EVICT=.TRUE.
               RETURN
         3     EVICT=.FALSE.
               RETURN
               END

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      SUBROUTINE FACINP(BSEG, BTP, C, CF, D, DELT, DF,
     1                  ETP, IER, INPFIL, JFIELD, MD,
     2                  NC, NLC, NPT, SOURCE, NCLC, AA, LOGC)
C
C   THIS ROUTINE IS CALLED BY THE MAIN PROGRAM TO SUPERVISE THE READING
C   OF THE CONTROL INPUT FILE.
C
C   FORMAL PARAMETERS:
C     BSEG   -
C     BTP    -
C     C      -
C     CF     -
C     D      -
C     DELT   -
C     DF     -
C     ETP    -
C     IER    -
C     INPFIL -
C     JFIELD -
C     MD     -
C     NC     -
C     NLC    -
C     NPT    -
C     SOURCE -
C     NCLC   -
C     AA     -
C
C    CALLED BY: FRANCO
C
      INCLUDE 'SY:FRANCO.PRM'
      BYTE INPFIL(30), SOURCE(7), TITLE(80), TUNIT(6), LETRC, LETRD
C
      INTEGER*2 OPTC, OPTD, BSEG
C
      INTEGER*4 BTP, ETP
C
      LOGICAL*1 LOGC
C
      DIMENSION C(1), D(1), CF(NLCF,NLCP), DF(NLCF,NLCP), AA(4,NLCF)
C
      DATA LETRC / 'C' /, LETRD / 'D' /
C
C     *** RECORD 1.0 ***
C          TITLE - 80 COLUMNS USED TO TITLE THE OUTPUT
      READ(1,1) TITLE
      WRITE(LP,2) TITLE
C
C     *** RECORD 2.0 ***
C          INPFIL - INPUT FILE CONTAINING CALCULATED CONCENTRATIONS
C          SOURCE - KEYWORD IDENTIFING THE DATA TO BE ANALYSIZED
C                   = 'ARM    '; DATA IS THE OUTPUT OF AN ARM SIMULATION
C                   = 'SERATRA'; DATA IS THE OUTPUT OF A SERATRA
C                                SIMULATION
C
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```
C          JFIELD = DATA FIELD TO BE ANALYSIZED
C
         READ(1,3) SOURCE,JFIELD,NCHR,(INPFIL(I),I=1,30)
         INPFIL(NCHR+1) = 0
         WRITE(LP,4) (INPFIL(I),I=1,NCHR)
         WRITE(LP,5)
         WHEN (SOURCE(1) .EQ. 'A') WRITE(LP,6)
         ELSE WRITE(LP,7)
         WRITE(LP,8) JFIELD
C
C        *** RECORD 3.0 ***
         WHEN (SOURCE(1) .EQ. 'S')
C        .       BTP   = BEGINNING TIME PLANE NUMBER
C        .       ETP   = ENDING TIME PLANE NUMBER
C        .       BSEG  = BEGINNING SEGMENT NUMBER
C        .       DELT  = TIME STEP TAKEN DURING THE SERATRA SIMULATION
C        .       TUNIT = UNITS OF THE TIME STEP ('DAY', 'HOUR', OR 'MINUTE')
C        .
         .  READ(1,29) BTP,ETP,BSEG,DELT,TUNIT
         .  WRITE(LP,30) BTP,ETP,BSEG
         .  WRITE(LP,12) DELT,TUNIT
         ...FIN
         ELSE
C        .       BTP    = BEGINNING TIME PLANE NUMBER
C        .       ETP    = ENDING TIME PLANE NUMBER
C        .       DELT   = TIME STEP TAKEN BY DURING THE ARM SIMULATION
C        .       TUNIT  = UNITS OF DELT ('DAY', 'HOUR', OR 'MINUTE')
C        .
         .  READ(1,9) BTP,ETP,DELT,TUNIT
         .  WRITE(LP,10) BTP
         .  WRITE(LP,11) ETP
         .  WRITE(LP,12) DELT,TUNIT
         ...FIN
         IF (BTP .GT. ETP)
         .  IER = 1
         .  WRITE(LP,13)
         ...FIN
C
C        *** RECORD 4.0 ***
C              LOGC   = =T; SUMMARY STATISTICS PERFORMED WITH THE NATURAL L
C                                 OF THE CONCENTRATIONS
C             OPTC   = CONTROL VARIABLE THAT SIGNALS THE METHOD TO BE USED
C                        WHEN INPUTTING SPECIFIED CONCENTRATION VALUES
C             OPTD   = CONTROL VARIABLE THAT SIGNALS THE METHOD TO BE USED
C                        WHEN INPUTTING SPECIFIED DURATIONS
C
         READ(1,37) LOGC,OPTC,OPTD
         WHEN (LOGC) WRITE(LP,36)
         ELSE WRITE(LP,35)
         WRITE(LP,15) OPTC
C
C        *** RECORD SETS 5.0, 6.0, AND 7.0 ***
C             SPECIFIED CONCENTRATION LEVELS
C               THE RECORD SET DEPENDS UPON THE VALUE OF OPTC
C                 =1; RECORD SET 5.0
C                 =2; RECORD SET 6.0
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C               =3, RECORD SET 7.0
          IER = 0
          SELECT (OPTC)
          .  (1) CALL OPT1(JC, C, LETRC, NC, IER)
          .  (2) CALL OPT2(JC, C, LETRC, NC, IER)
          .  (3) CALL OPT3(JC, C, LETRC, NC, IER)
          .  (OTHERWISE)
          .  .  IER=2
          .  .  WRITE(LP,16)
          .  .  WRITE(LP,17)
          .  .  WRITE(LP,18)
          .  ...FIN
          ...FIN
          IF (IER .EQ. 2) RETURN
C
C         *** RECORD SETS 8.0, 9.0, AND 10.0 ***
C              SPECIFIED DURATIONS
C                RECORD SET DEPENDS UPON THE VALUE OF OPTD
C                 =1, RECORD SET 8.0
C                 =2, RECORD SET 9.0
C                 =3, RECORD SET 10.0
          IER = 0
          WRITE(LP,20) OPTD
          SELECT (OPTD)
          .  (1) CALL OPT1(JD, D, LETRD, MD, IER)
          .  (2) CALL OPT2(JD, D, LETRD, MD, IER)
          .  (3) CALL OPT3(JD, D, LETRD, MD, IER)
          .  (OTHERWISE)
          .  .  IER = 2
          .  .  WRITE(LP,16)
          .  .  WRITE(LP,19)
          .  .  WRITE(LP,18)
          .  ...FIN
          ...FIN
          IF (IER .EQ. 2) RETURN
C
C         *** RECORD 11.0 ***
C              NLC     = NUMBER OF LC PIECEWISE LINEAR FUNCTIONS
C              NPT     = NUMBER OF CONCENTRATION, DURATION PAIRS USED TO
C                          DESCRIBE EACH FUNCTION
C
          READ(1,14) NLC,NPT
          IER = 0
          WHEN (NLC .EQ. 0) WRITE(LP,21)
          ELSE
          .  WRITE(LP,22) NLC,NPT
          .  IF(NLC .GT. NLCF)
          .  .  IER = 2
          .  .  WRITE(LP,16)
          .  .  WRITE(LP,23) NLCF
          .  .  WRITE(LP,18)
          .  ...FIN
          .  IF (NPT .LT. 3 .OR. NPT .GT. NLCP)
          .  .  IER = 2
          .  .  WRITE(LP,16)
          .  .  WRITE(LP,24) NLCP
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                . .  WRITE(LP,18)
                .  ...FIN
                .  UNLESS (IER .EQ. 2)
      C         . .  *** RECORD SET 12.0 ***
      C         . .        NPT JOINT CONCENTRATION-DURATION PAIRS
                . .  WRITE(LP,25) (I,I=1,NPT)
                . .  DO (I=1,NLC)
                . . .  READ(1,26) (CF(I,J),DF(I,J),J=1,NPT)
                . . .  WRITE(LP,27) I,(DF(I,J),J=1,NPT)
                . . .  WRITE(LP,28) (CF(I,J),J=1,NPT)
                . .  ...FIN
                .  ...FIN
                ...FIN
      C         *** RECORD SET 13.0 ***
      C               NCLC - NUMBER OF LC CONTINUOUS FUNTIONS
      C
                READ(1,14) NCLC
                WHEN (NCLC .EQ. 0) WRITE(LP,31)
                ELSE
                .  WHEN (NCLC+NLC .GT. NCLF)
                . .  IER = 2
                . .  WRITE(LP,16)
                . .  WRITE(LP,32) NLCF,NLC,NCLC
                .  ...FIN
                .  ELSE
                . .  WRITE(LP,33)
                . .  WRITE(LP,25) (I,I=1,4)
      C         . .  *** RECORD SET 14 ***
      C         . .        NCLC SETS OF 4 CONSTANTS DESCRIBING EACH LC CONTINUOUS FUNCTI
                . .  DO (I=1,NCLC)
                . . .  READ(1,26) (AA(J,I),J=1,4)
                . . .  WRITE(LP,34) I,(AA(J,I),J=1,4)
                . .  ...FIN
                .  ...FIN
                ...FIN
                RETURN
      C
      1         FORMAT(80A1)
      2         FORMAT(62X,'FRANCO'/62X,6('-')/62X,6('=')///25X,80A1)
      3         FORMAT(7A1,I5,1X,Q,30A1)
      4         FORMAT(10X,'CALCULATED CONCENTRATIONS INPUT FILE NAME',
               1 9X,'--',30A1)
      5         FORMAT(10X,'CONCENTRATIONS ARE THE RESULTS FROM',15X,'--')
      6         FORMAT(1H+,61X,'AN ARM SIMULATION')
      7         FORMAT(1H+,61X,'A SERATRA SIMULATION')
      8         FORMAT(10X,'THE DATA FIELD TO BE ANALYSIZED IS NUMBER',
               1 9X,'--',I5)
      9         FORMAT(2I5,F10.0,6A1)
      10        FORMAT(10X,'STARTING TIME STEP NUMBER',9X,'--',I5)
      11        FORMAT(10X,'ENDING TIME STEP NUMBER',11X,'--',I5)
      12        FORMAT(10X,'ANALYSIS TIME STEP',32X,'--',F10.2,1X,6A1)
      13        FORMAT(//'STARTING TIME IS LATER THEN THE ENDING TIME')
      14        FORMAT(2I5)
      15        FORMAT(10X,'CONCENTRATION INPUT METHOD',24X,'--',I5)
      16        FORMAT(1H0,99X,'***** FATAL ERROR *****')
      17        FORMAT(50X,'INVALID VALUE FOR THE SPECIFIED CONCENTRATION',
           1 ' INPUT CONTROL VARIABLE = OPTC')
      18    FORMAT(101X,'SCANNING WAS SUSPENDED')
      19    FORMAT(50X,'INVALID VALUE FOR THE SPECIFIED DURATION INPUT',
           1 ' CONTROL VARIABLE = OPTD')
      20    FORMAT(10X,'DURATION INPUT METHOD',29X,'--',I5)
      21    FORMAT(10X,'NO LCPIECEWISE LINEAR FUNCTION EXCEEDANCE ANALYSIS'
           1 ' TO BE PERFORMED')
      22    FORMAT(10X,'GLOBAL EXCEEDANCE INPUT'/
           1 15X,'NUMBER OF PIECEWISE LINEAR FUNCTIONS',9X,'--',I5/
           2 15X,'NUMBER OF DURATION, CONCENTRATION PAIRS',6X,'--',I5)
      23    FORMAT(50X,'INVALID NUMBER OF LC PIECEWISE LINEAR FUNCTIONS',
           1  '(',I2,' MAXIMUM ALLOWED)')
      24    FORMAT(50X,'INVALID NUMBER OF LC PIECEWISE LINEAR FUNCTION',
           1 ' PAIRS'/50X,'(MUST BE AT LEAST 3 AND NO MORE THAN ',
           2 I2,')')
      25    FORMAT(20X,'FUNCTION',8X,6(13X,I2))
      26    FORMAT(8F10.0)
      27    FORMAT(23X,I1,5X,'DURATION',4X,6(2X,1PE12.5))
      28    FORMAT(29X,'CONCENTRATION',1X,1PE12.5,5(2X,1PE12.5))
      29    FORMAT(2I10,I5,F10.0,6A1)
      30    FORMAT(10X,'STARTING TIME STEP NUMBER',25X,'--',I10/
           1 10X,'ENDING TIME STEP NUMBER',27X,'--',I10/
           2 10X,'ANALYZING SEGMENT NUMBER',26X,'--',I5)
      31    FORMAT(10X,'NO LC CONTINUOUS FUNCTION EXCEEDANCE ANALYSIS TO',
           1 ' BE PERFORMED')
      32    FORMAT(50X,'THE SUM OF NLC+NCLC MUST NOT EXCEED ',I2,/
           1 50X,'NLC =',I2/50X,'NCLC='I2)
      33    FORMAT(//34X,'LC CONTINUOUS FUNCTION DEFINED BY FOUR CONSTANTS')
      34    FORMAT(23X,I1,5X,'CONSTANTS',3X,4(2X,1PE12.5))
      35    FORMAT(10X,'DATA ANALYZED IS',34X,'-- RAW')
      36    FORMAT(10X,'DATA ANALYZED IS',34X,'-- LOG')
      37    FORMAT(L1,2I5)
            END

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              SUBROUTINE FRAC(NE,NT,NTIM,NC,MD,P,C,D)
        C
        C   THIS ROUTINE COMPUTES, PRINTS AND SAVES THREE ITEMS*
        C      PE(I,J)  - FRACTION OF THE EVENTS THE CALCULATED CONCENTRATION
        C                 IS C(I) OR GREATER THAT THE CONCENTRATION REMAINED
        C                 GREATER THAN OR EQUAL TO C(I) FOR A DURATION OF
        C                 D(J) OR GREATER.
        C
        C      PT(I,J)  - FRACTION OF TIME THE CALCULATED CONCENTRATION IS C(I)
        C                 OR GREATER THAT THE CONCENTRATION REMAINED GREATER
        C                 THAN OR EQUAL TO C(I) FOR A DURATION OF D(J) OR GREATE
        C
        C      PTT(I,J) - FRACTION OF THE TOTAL TIME PERIOD THAT THE CALCULATED
        C                 CONCENTRATION REMAINED GREATER THAN OR EQUAL TO C(I)
        C                 FOR A DURATION OF D(J) OR GREATER.
        C
        C   INPUT VARIABLES
        C      NE(I,J) - ACTUAL NUMBER OF EVENTS OCCURING OF DURATION D(J)
        C                OR GREATER AND CONCENTRATION C(I)  OR GREATER.
        C      NT(I,J) - NUMBER OF TIME STEPS COVERED BY THE EVENTS THAT ARE OF
        C                DURATION D(J) OR GREATER FOR CONCENTRATIONS C(I)
        C                OR GREATER.
        C      NTIM    - NUMBER OF TIME STEPS ANALIZED
        C      NC      - NUMBER OF SPECIFIED CONCENTRATIONS
        C      MD      - NUMBER OF SPECIFIED DURATIONS
        C      P(I,J)  - ARRAY USED FOR CALCULATIONS (SCRATCH PAD)
        C     C       - SPECIFIED CONCENTRATION VALUES
        C     D       - SPECIFIED DURATION VALUES
        C
               INCLUDE 'SY:FRANCO.PRM'
        C
               BYTE HEAD1,HEAD2,HEAD3,HEAD4,HEAD5,HEAD6
        C
               INTEGER*4 NT(JC,JD),NTIM
        C
               DIMENSION NE(JC,JD),P(JC,JD),C(JC),D(JD),
              1  HEAD1(80),HEAD2(80),HEAD3(80),HEAD4(80),HEAD5(80),HEAD6(80)
        C
               DATA HEAD1/12*' ','P','E','R','C','E','N','T','A','G','E',' ',
              1 'O','F',' ','E','V','E','N','T','S',' ','W','I','T',
              2 'H',' ','A',' ','D','U','R','A','T','I','O','N',
              3 ' ','O','F',' ','D','(','J',')',' ','O','R',' ',
              4 'G','R','E','A','T','E','R',13*' '/
               DATA HEAD2/8*' ','G','I','V','E','N',' ','T','H','A','T',' ',
              1 'T','H','E',' ','E','V','E','N','T',' ','I','S',
              2 ' ','D','E','F','I','N','E','D',' ','B','Y',' ','C',
              3 'O','N','C','E','N','T','R','A','T','I','O','N',
              4 'S',' ','C','(','I',')',' ','O','R',' ','G','R',
              5 'E','A','T','E','R',7*' '/
               DATA HEAD3/8*' ','P','E','R','C','E','N','T','A','G','E',' ',
              1 'O','F',' ','T','I','M','E',' ','E','V','E','N',
              2 'T','S',' ','W','I','T','H',' ','D','U','R','A',
              3 'T','I','O','N','S',' ','O','F',' ','D','(','J',
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        4 ')',' ','O','R',' ','G','R','E','A','T','E','R',
        5 ' ','O','C','C','U','R',7*' '/
         DATA HEAD4/8*' ','G','I','V','E','N',' ','T','H','A','T',' ',
        1 'T','H','E',' ','E','V','E','N','T',' ','I','S',
        2 ' ','D','E','F','I','N','E','D',' ','B','Y',
        3 'C','O','N','C','E','N','T','R','A','T','I','O',
        4 'N','S',' ','C','(','I',')',' ','O','R',' ','G',
        5 'R','E','A','T','E','R',8*' '/
C
         DATA HEAD5 /8*' ','P','E','R','C','E','N','T','A','G','E',' ',
        1 'O','F',' ','T','O','T','A','L',' ','T','I','M',
        2 'E',' ','P','E','R','I','O','D',' ','E','V','E',
        3 'N','T','S',' ','W','I','T','H',' ','D','U','R',
        4 'A','T','I','O','N','S',' ','O','F',' ','D','(','J',
        5 ')',' ','O','R',8*' '/
         DATA HEAD6/7*' ','G','R','E','A','T','E','R',' ','O','C','C',
        1 'U','R',' ','F','O','R',' ','E','V','E','N','T',
        2 'S',' ','D','E','F','I','N','E','D',' ','B','Y',
        3 ' ','C','O','N','C','E','N','T','R','A','T','I',
        4 'O','N','S',' ','C','(','I',')',' ','O','R',' ',
        5 'G','R','E','A','T','E','R',7*' '/
C
C        *** PE CALCULATIONS ***
         DO (I=1,NC)
         .  DO (J=1,MD)
         .  .  P(I,J)=0.
         .  .  IF(NE(I,1) .NE. 0) P(I,J)=FLOAT(NE(I,J))/FLOAT(NE(I,1))*100.
         .  ...FIN
         ...FIN
C
         CALL MATPRT(C,D,NE,NT,P,NC,MD,HEAD1,HEAD2,2)
C
C        *** PT CALCULTIONS ***
         DO (I=1,NC)
         .  DO (J=1,MD)
         .  .  P(I,J)=0.
         .  .  IF(NT(I,1) .NE. 0) P(I,J)=FLOAT(NT(I,J))/FLOAT(NT(I,1))*100.
         .  ...FIN
         ...FIN
C
         CALL MATPRT(C,D,NE,NT,P,NC,MD,HEAD3,HEAD4,2)
C
C        *** PTT CALCULATIONS ***
         FT=NTIM
         DO (I=1,NC)
         .  DO (J=1,MD)
         .  .  P(I,J)=FLOAT(NT(I,J))/FT*100.
         .  ...FIN
         ...FIN
C
         CALL MATPRT(C,D,NE,NT,P,NC,MD,HEAD5,HEAD6,2)
C
         RETURN
         END

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      ----------------------------------------

              SUBROUTINE GAMCUM(X,ALPHA,BETA,P)
      C
      C       FORM OF GAMMA IS U**(ALPHA-1) * EXP(BETA*U)
      C
      C       FOR CHI SQUARE DISTRIBUTION ENTER ALPHA= DF/2 AND BETA= 1/2
      C
      C       GAMCUM COMPUTES THE VALUE OF THE CUMULATIVE GAMMA DISTRIBUTION
      C       (P) WITH THE LIMITS OF INTEGRATION FROM 0 TO X.
      C
      C       IF X.GE.(ALPHA/2 +4) THE ASYMPTOTIC EXPANSION GIVEN BY
      C       EQ. 6.5.32 IN ABRAMOWITZ AND STEGUN IS USED.
      C
      C       OTHERWISE, A CONFLUENT HYPERGEOMETRIC FUNCTION REPRESENTATION
      C       FOR THE INCOMPLETE GAMMA FUNCTTON IS USED. SEE EQUATIONS
      C      6.5.12 AND 13.1.2 IN ABRAMOWITZ AND STEGUN.
      C
      C       THE RESULTS OF THE ROUTINE WERE CHECKED AGAINST TABLE 26.7
      C       IN ABRAMOWITZ AND STEGUN
      C
      C       PROGRAMMED AND CHECKED BY AR(TONY) OLSEN
      C       DATE: SEPTEMBER 29,1978
      C
      C      !!!!! NO ERROR CHECKING OF INPUT ARGUMENTS !!!!!!!!!
      C
              DATA ERR/1.E-4/
              A = ALPHA
              IF(X.GT.0.) GO TO 1
              P = 0.
              RETURN
      1       Y = BETA*X
              IF(Y.LT.(A/2. + 4.)) GO TO 30
              SUM =1.
              R = 1.
              L = INT(A)
              DO 10 I = 1,L
              AI = I
              R = R*(A-AI)/Y
              IF(R.LT.ERR) GO TO 20
      10      SUM = SUM + R
      20      P = 1. - SUM*EXP((A-1.)*ALOG(Y) - Y - GAMLN(A))
              RETURN
      30      SUM = 1.
              R =1.
              DO 40 I=1,50
              AI = I
              R = R*Y/(A + AI)
              IF(R.LT.ERR) GO TO 50
      40      SUM = SUM + R
      50      P = SUM/A*EXP(A*ALOG(Y) -Y -GAMLN(A))
              RETURN
              END

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              FUNCTION GAMFN1(X,A)
        C
        C---- FUNCTION USED EXCLUSIVELY WITH GAMPPF SUBROUTINE.
        C     REFER TO IT FOR OPERATION
        C
              AJ=0.
              D=1./A
              T=D
           10 AJ=AJ+1.
              D=D*X/(A+AJ)
              T=T+D
              IF((AJ-1.).LE.(X-A)) GO TO 10
              IF((X*D/(A+AJ-1.-X)/T).LT.1.E-7) GO TO 20
              GO TO 10
           20 GAMFN1=A*ALOG(X)-X+ALOG(T)
              RETURN
              END

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            FUNCTION GAMLN(A)
      C
      C---- COMPUTES LN(GAMMA(A))
      C
      C---- FOR A.LT.4 USES RATIONAL FUNCTION EXPANSION GIVEN BY
      C     WILK,GNANADESIKAN,HUYETT(1962) TECHNOMETRICS 4,1-18
      C     ATTRIBUTED TO HASTINGS(1955) APPROXIMATIONS FOR
      C     DIGITAL COMPUTERS.
      C
      C     FOR A.GE.4 THE ASYMPTOTIC EXPANSION GIVEN BY EQ.6.1.41
      C     IN ABRAMOWITZ AND STEGUN IS USED.
      C
      C---- THE RESULTS WERE CHECKED AGAINST THE VALUES TABLED IN
      C     ABRAMOWITZ AND STEGUN, PP. 267 AND 274
      C
      C---- NO INTERNAL CHECK ON INPUT ARGUMENT FOR VALUES LT. 1!!!!
      C
      C---- PROGRAMMED AND CHECKED BY AR(TONY) OLSEN
      C     DATE: SEPTEMBER 29,1978
      C
            DIMENSION B(8),C(4)
            DATA B/.577191652,.988205891,.897056937,.918206857,
           1      .756704078,.482199394,.193527818,.035868343/
            DATA C/12.,-360.,1260.,-1680./
      C
            IF(A.GE.4.) GO TO 100
      C
      C---- RATIONAL FUNCTION APPROXIMATION A.LT.4
      C
            IA=INT(A)-1
            AF=A-AINT(A)
            G=B(8)*AF
            DO 10 J=1,7
            I=8-J
         10 G=(B(I)-G)*AF
            G=1.-G
            IF(IA) 20,50,30
         20 G=G/A
            GO TO 50
         30 DO 40 I=1,IA
            AI=I
         40 G=G*(AF+AI)
         50 GAMLN=ALOG(G)
            RETURN
      C
      C---- ASYMPTOTIC APPROXIMATION FOR A.GE.4
      C
        100 G=0.
            DO 110 I=1,4
        110 G=G+1./(C(I)*A**(2*I-1))
            GAMLN=A*(ALOG(A)-1.)+ALOG(6.2831853/A)/2.+G
            RETURN
            END
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              SUBROUTINE GAMML(AMEAN,GMEAN,A,B)
        C     GAMML COMPUTES MAXIMUM LIKELIHOOD ESTIMATES FOR THE
        C       GAMMA DISTRIBUTION PARAMETERS ALPHA AND BETA. THE DENSITY
        C       FOR THE GAMMA IS GIVEN AS
        C
        C     G(X;A,B) = B**A*X**(A-1)*EXP(-B*X)/G(A)
        C
        C     THE ESTIMATES ARE OBTAINED BY USING NEWTON-RAPHSON
        C       METHOD AS DESCRIBED FOR THIS CASE BY
        C     CHOI AND WETTE,TECHNOMETRICS 11:683-690,1969
        C
        C     INPUT: AMEAN = ARITHMETIC MEAN OF SAMPLE
        C            GMEAN = GEOMETRIC  MEAN OF SAMPLE
        C       OUTPUT:  A    = ALPHA MAXIMUM LIKELIHOOD ESTIMATE
        C                B    = BETA  MAXIMUM LIKELIHOOD ESTIMATE
        C
        C     PROGRAMMED AND CHECKED BY AR(TONY) OLSEN
        C     DATE: OCTOBER 2, 1978
        C
              Y = ALOG(AMEAN/GMEAN)
              A = 1./(2.*Y)
        10    L = INT(A)-4
              IF(L.GE.0) GO TO 30
              A = A-L
        30    X = A*A
              Y9 = -6./A-(1.-(.1-(1./21.-.5/X)/X)/X)/X+12.*Y
              Y8 = 6./X + (2.-(.4-(2./7.-.4/X)/X)/X)/(A*X)
              IF(L.GE.0) GO TO 50
              A = A +L
              LL = -L
              DO 40 I= 1,LL
              Y9 = Y9 -12./(A +(I-1))
              Y8 = Y8 +12./((A+(I-1))*(A+(I-1))*(A+I))
        40    CONTINUE
              Y9 = Y9 + 12.*ALOG(1-L/A)
        50    DELTA = Y9/Y8
              A = A - DELTA
              IF(ABS(DELTA).LT.1.0E-4) GO TO 60
              GO TO 10
        60    B = A/AMEAN
              RETURN
              END

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                 SUBROUTINE GAMPPF(NOPRAM,PARAM,P,PPF,NAMPRT)
          C
          C                FORM OF GAMMA IS X**(ALPHA-1) * EXP(BETA*X)
          C
          C                FOR CHI SQUARE DISTRIBUTION QUANTILES ENTER
          C                        ALPHA =DF/2 AND BETA = 1/2
          C
          C---- GAMPPF COMPUTES THE PROBABILITY POINT FUNCTION (QUANTILE)
          C     FOR THE GAMMA DISTRIBUTION GIVEN A PROBABILITY P.
          C
          C---- THE ALGORITHM IS GIVEN BY WILK,GNANADESIKAN,HUYETT(1962)
          C     TECHNOMETRICS 4:1-18
          C
          C
          C---- THE RESULTS WERE CHECK AGAINST THEIR TABLES.
          C
          C---- EXTERNALS REQUIRED: GAMFN1, GAMLN
          C
          C---- PROGRAMMED AND CHECKED BY AR(TONY) OLSEN
          C     DATE : SEPTEMBER 29,1978
          C
          C
                COMMON/IODEV/IPR,IRD
          C
                LOGICAL NAMPRT
          C
                REAL LHS
          C
                DIMENSION PARAM(2)
          C
                IF(NOPRAM) 2,1,2
          C---- DEFAULT VALUES FOR PARAMETERS
              1 ALPHA=1.
                BETA =1.
                GO TO 3
              2 ALPHA=PARAM(1)
                BETA =PARAM(2)
              3 IF(NAMPRT) GO TO 60
          C
                PPF=0.
                IF(P.LE.0.) RETURN
                PPF=1.
                PPF=1.
                IF(P.GE.1) RETURN
          C
          C---- COMPUTE RIGHT HAND SIDE OF EQUATION IN LOG FORM
          C     FIND LOWER BOUND FOR PPF
          C
                A=ALPHA
                R=GAMLN(A)
                RHS=ALOG(P)+R
                XLB=EXP((ALOG(P*A)+R)/A)
          C
```

```
C---- FIND MULTIPLE OF LOWER BOUND SUCH THAT LHS.GT.RHS
C
      R=1.
   10 X=R*XLB
      LHS=GAMFN1(X,A)
      IF(LHS.GT.RHS) GO TO 20
      R=R+1.
      GO TO 10
C
C---- USE METHOD OF HALVING INTERVALS TO DETERMINE X
C
   20 XL=(R-1.)*XLB
      XU=R*XLB
      XPRE=XU
   30 X=(XL+XU)/2.
      IF(ABS((X-XPRE)/X).LT.1E-5) GO TO 50
      XPRE=X
      LHS=GAMFN1(X,A)
      IF(LHS.GT.RHS) GO TO 40
      XL=X
      GO TO 30
   40 XU=X
      GO TO 30
   50 PPF=X/BETA
C
      RETURN
C---- WRITE TITLE AND RETURN
   60 WRITE (IPR,1000) ALPHA,BETA
 1000 FORMAT(20X,27HEXPECTED GAMMA WITH ALPHA =F9.4,
     1  13H,  AND BETA =1PE15.7)
      RETURN
      END
```

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              SUBROUTINE LCCONT(CJ,NDCJ,NTIM,DELT,AA,NCLC,NLC,NREC,LUN)
        C
        C   THE PURPOSE OF THIS ROUTINE IS TO DETERMINE IF THE CONDITIONS
        C   OF THE EVENT CAUSE EXCEEDANCE OF ANY OF THE LC CONTINUOUS
        C   FUNCTIONS, THOSE THAT DO ARE WRITTEN TO THE FILE CORRESPONDING TO
        C   THE CURVE THAT HAS BEEN EXCEEDED FOR FURTHER PROCESSING.
        C
        C     CJ   =
        C     NDCF =
        C     NTIM =
        C     DELT =
        C     AA   =
        C     NCLC =
        C     NLC  =
        C     NREC =
        C     LUN  =
        C
              INCLUDE 'SY:FRANCO.PRM'
        C
              INTEGER*4 NDCJ,NTIM
        C
              DIMENSION AA(4,NLCF),NREC(NLCF),LUN(NLCF)
        C
              D = NDCJ*DELT
              DO (J=1,NCLC)
              .  IF (D .GT. AA(2,J))
              .  .  FD = AA(1,J) + (AA(3,J)/(D-AA(2,J)))**(1./AA(4,J))
              .  .  IF (CJ .GE. FD)
              .  .  .  K = NREC(NLC+J)
              .  .  .  WRITE(LUN(NLC+J)'K) NTIM,NDCJ,CJ
              .  .  ...FIN
              .  ...FIN
              ...FIN
              RETURN
              END

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          ----------------------------------------
                SUBROUTINE LCFINI(NREC,LUN,NLC,NTIM,CF,DF,NPT,NCLC,AA,A,B,DELT)
          C
          C    THIS SUBROUTINE FINISHED THE LC50 DETERMINATIONS, IT EXAMINS THE
          C    DIRECT ACCESS FILE FOR EACH LC FUNCTION AND ELIMINATES THOSE RECORDS
          C    THAT WOULD CAUSE DOUBLE COUNTS.  THE REMAINING RECORDS ARE
          C    WRITTEN TO PERMANENT FILES WHICH WILL CONTAIN ONLY THE EVENTS THAT
          C    EXCEED THE LC50 CURVE.  IT ALSO PRINTS A SUMMARY OF EACH FILE.
          C
          C       NREC(I) = THE NUMBER OF RECORDS IN THE FILE FOR FUNCTION I
          C       LUN(I)  = LOGICAL UNIT NUMBER OF THE FILE FOR FUNCTION I
          C       NLC     = NUMBER OF LC FUNCTIONS
          C       NTIM    = NUMBER OF TIME STEPS PROCESSED DURING ANALYSIS
          C       CF      =
          C       DF      =
          C       NPT     =
          C       NCLC    =
          C       AA      =
          C       A       =
          C       B       =
          C       DELT    =
          C
                INCLUDE 'SY:FRANCO.PRM'
          C
                INTEGER*4 NOCJ,NOCJP,KTIM,KTIMP,NTG,NTIM
          C
                DIMENSION NREC(NLCP),LUN(NLCP),CF(NLCP,NLCP),DF(NLCP,NLCP),
               1          AA(4,NLCP),A(NLCP,NLCP),B(NLCP,NLCP)
          C
                WRITE(LP,1)
                IF (NLC .GT. 0)
                .  WRITE(LP,2) (I,I=1,NPT)
                .  DO (I=1,NLC)
                .  .  WRITE(LP,3) I,(DF(I,J),J=1,NPT)
                .  .  WRITE(LP,4) (CF(I,J),J=1,NPT)
                .  ...FIN
                .  WRITE(LP,5) (I,I=1,NPT-1)
                .  DO (I=1,NLC)
                .  .  WRITE(LP,6) I,(A(I,J),J=1,NPT-1)
                .  .  WRITE(LP,7) (B(I,J),J=1,NPT-1)
                .  ...FIN
                ...FIN
                IF (NCLC .GT. 0)
                .  WRITE(LP,8) (I,I=1,4)
                .  DO (I=1,NCLC)
                .  .  WRITE(LP,9) I,(AA(J,I),J=1,4)
                .  ...FIN
                ...FIN
                CALL ASNLUN(1,'SY',0)
                DO (I=1,NLC+NCLC)
                .  K=NREC(I)-1
                .  WHEN (K  .NE. 0)
                .  .  L=LUN(I)          !  AS NCLP INCREASES SO MUST THE NUMBER OF FILES
          C     .  .                          BEING OPENED BELOW
```

```
      .  .  SELECT (I)
      .  .  .  (1) OPEN(UNIT=1,NAME='LC1SAVE.RLT',TYPE='NEW',FORM='UNFORMATTED')
      .  .  .  (2) OPEN(UNIT=1,NAME='LC2SAVE.RLT',TYPE='NEW',FORM='UNFORMATTED')
      .  .  .  (3) OPEN(UNIT=1,NAME='LC3SAVE.RLT',TYPE='NEW',FORM='UNFORMATTED')
      .  .  .  (4) OPEN(UNIT=1,NAME='LC4SAVE.RLT',TYPE='NEW',FORM='UNFORMATTED')
      .  .  .  (5) OPEN(UNIT=1,NAME='LC5SAVE.RLT',TYPE='NEW',FORM='UNFORMATTED')
      .  .  ...FIN
C     .  .
C     .  .  *** SEARCH FOR AND SAVE THE VALID RECORDS ***
      .  .  NEG=0
      .  .  NTG=0
      .  .  MREC=K
      .  .  READ(L'MREC) KTIMP,NDCJP,CJP
      .  .  IF (K .GT. 1)
      .  .  .  DO (J=2,K)
      .  .  .  .  MREC=MREC-1
      .  .  .  .  READ(L'MREC) KTIM,NDCJ,CJ
      .  .  .  .  IF(KTIM .LE. KTIMP - NDCJP)
      .  .  .  .  .  NEG=NEG+1
      .  .  .  .  .  NTG=NTG+NDCJP
      .  .  .  .  .  WRITE(1) KTIMP,NDCJP,CJP
      .  .  .  .  .  KTIMP=KTIM
      .  .  .  .  .  NDCJP=NDCJ
      .  .  .  .  .  CJP=CJ
      .  .  .  .  ...FIN
      .  .  .  ...FIN
C     .  .  .  *** SAVE THE LAST EVENT ***
      .  .  ...FIN
      .  .  WRITE(1) KTIMP,NDCJP,CJP
      .  .  NEG=NEG+1
      .  .  NTG=NTG+NDCJP
      .  .  PG=FLOAT(NTG)/FLOAT(NTIM) * 100.
      .  .  TT = DELT * NTG
      .  .  IF (I .EQ. 1) WRITE(LP,10)
      .  .  WRITE(LP,11) I,NEG,NTG,TT,PG
      .  .  CLOSE(UNIT=1)
      .  ...FIN
      .  ELSE
      .  .  NEG = 0
      .  .  NTG = 0
      .  .  TT = 0.0
      .  .  PG = 0.0
      .  .  IF(I .EQ. 1) WRITE(LP,10)
      .  .  WRITE(LP,11) I,NEG,NTG,TT,PG
      .  ...FIN
      ...FIN
      RETURN
C
    1 FORMAT(1H1,46X,'GLOBAL EXCEEDANCE SUMMARY'//)
    2 FORMAT(32X,'LC PIECEWISE LINEAR FUNCTIONS DEFINED BY JOINT',
     1 ' PAIRS'//61X,'JOINT POINTS'/9X,'FUNCTION',9X,6(15X,I1))
    3 FORMAT(13X,I1,4X,'DURATION!',6X,6(1PE13.5,2X))
    4 FORMAT(18X,'CONCENTRATION!',1X,6(1PE13.5,2X))
    5 FORMAT(//21X,'LC PIECEWISE LINEAR FUNCTIONS DEFINED BY INTERCEPT',
     1 ' AND SLOP (A+B(DURATION))'//58X,'SEGMENT'/9X,'FUNCTION',
     2 9X,5(15X,I1))
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        6      FORMAT(13X,I1,4X,'INTERCEPT:',5X,5(1PE13.5,2X))
        7      FORMAT(18X,'SLOPE:',9X,5(1PE13.5,2X))
        8      FORMAT(//34X,'LC CONTINUOUS FUNCTIONS DEFINED BY FOUR CONSTANTS'
              1 //9X,'FUNCTION',9X,5(13X,I1))
        9      FORMAT(13X,I1,4X,'CONSTANTS:',5X,5(1PE13.5,2X))
        10     FORMAT(//8X,'EXCEEDANCE SUMMARY'/20X,'NUMBER',4X,'NUMBER OF',
              1 ' TIME PLANES',5X,'DURATION WHILE',6X,'GLOBAL EXCEEDANCE'/
              2 9X,'FUNCTION',2X,'OF EVENTS',2(2X,'GREATER THAN FUNCTION'),
              3 6X,'(PERCENT)')
        11     FORMAT(13X,I1,7X,I5,11X,I5,16X,F7.1,16X,F6.2)
               END

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              SUBROUTINE LCPREP(CJ,NOCJ,NTIM,DELT,A,B,DF,NLC,NPT,NREC,LUN)
        C
        C   THE PURPOSE OF THIS ROUTINE IS TO DETERMINE IF THE CONDITIONS
        C   OF THE EVENT CAUSE EXCEEDANCE OF ANY OF THE LC PIECEWISE LINEAR
        C   FUNCTIONS.  THOSE THAT DO ARE WRITTEN TO THE FILE CORRESPONDING TO
        C   THE CURVE THAT HAS BEEN EXCEEDED FOR FURTHER PROCESSING.
        C
        C     CJ      = INPUT CONCENTRATION VALUE C(J) OF THE EVENT
        C     NOCJ    = NUMBER OF TIME PLANES IN THE EVENT
        C     NTIM    = TIME PLANE NUMBER
        C     DELT    = TIME STEP SIZE
        C     A(I,J)  = INTERCEPT OF FUNCTION I, LINE SEGMENT L
        C     B(I,J)  = SLOPE OF FUNCTION I, LINE SEGMENT L
        C     DF(I,J) = TIME FOR FUNCTION I, POINT L
        C     NLC     = NUMBER OF LC50 FUNCTIONS
        C     NPT     = NUMBER OF POINTS USED TO DESCRIBE EACH FUNCTION
        C     NREC(I) = ASSOCIATE VARIABLE OF DIRECT ADDESS FILE FOR FUNCTION I
        C     LUN(I)  = LOGICAL UNIT NUMBER OF DIRECT ACCESS FILE FOR
        C               FUNCTION I
        C
              INCLUDE 'SY:FRANCO.PRM'
        C
              INTEGER*4 NTIM,NOCJ
              DIMENSION A(NLCP,NLCP),B(NLCP,NLCP),DF(NLCP,NLCP),
             1          NREC(NLCP),LUN(NLCP)
        C
              D=NOCJ*DELT
              DO (I=1,NLC)
              .  NOE=0
              .  L=1
              .  REPEAT UNTIL (L .GT. NPT-2 .OR. NOE .EQ. 1)
              .  .  WHEN (DF(I,L) .EQ. DF(I,L+1) .AND.  D .LT. DF(I,L+1))
        C     .  .  .  *** SPECIAL CASE (INFINITE SLOPE AND NO EXCEEDANCE)
              .  .  .  L=NPT
              .  .  ...FIN
              .  .  ELSE
              .  .  .  IF(DF(I,L) .EQ. DF(I,L+1)) L=L+1
              .  .  .  UNLESS (L .GT. NPT-2)
              .  .  .  .  IF(D .GE. DF(I,L) .AND. D .LE. DF(I,L+1))
              .  .  .  .  .  FD=A(I,L) + B(I,L)*D
              .  .  .  .  .  IF(CJ .GE. FD) NOE=1
              .  .  .  .  ...FIN
              .  .  .  ...FIN
              .  .  .  L=L+1
              .  .  ...FIN
              .  ...FIN
              .  IF(D .GE. DF(I,NPT-1))
              .  .  FD=A(I,NPT-1) + B(I,NPT-1)*D
              .  .  IF(CJ .GE. FD) NOE=1
              .  ...FIN
              .  IF(NOE .EQ. 1)
              .  .  K=NREC(I)
              .  .  WRITE(LUN(I)'K) NTIM,NOCJ,CJ
```

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 00054          .  ...FIN
 00055          ...FIN
 00056          RETURN
 00057          END
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                SUBROUTINE MATPRT(C,D,N,DN,R,MAXC,MAXD,LINE1,LINE2,TYPIND)
          C
          C     PRINT ROUTINE FOR 'FRANCO', MAY 1978.
          C
          C     C  ------ ARRAY CONTAINING CONCENTRATION VALUES
          C     D  ------ ARRAY CONTAINING DURATION VALUES
          C     N  ------ INTEGER*2 ARRAY CONTAINING FREQUENCY DISTRIBUTION VALUES
          C               FROM FRANCO
          C     DN ------ INTEGER*4 ARRAY CONTAINING VALUES FROM FRANCO
          C     R  ------ ONE OF THREE REAL ARRAYS CONTAINING SUMMARY DATA ON
          C               CONCENTRATION LEVELS OF SIGNIFICANT STRENGTH AND DURA-
          C               TION FROM FRAC
          C     MAXC ---- MAXIMUM NUMBER OF C VALUES
          C     MAXD ---- MAXIMUM NUMBER OF D VALUES
          C     LINE1,
          C      LINE2 -- TITLE LINES FOR PRINTOUT
          C     TYPIND -- REAL OR INTEGER VALUES TO BE OUTPUT
          C
          C
                INCLUDE 'SY:FRANCO.PRM'
          C
                DIMENSION C(1),D(1),R(JC,1)
          C
                INTEGER*2 N(JC,1),PGPRST,TYPIND
          C
                INTEGER*4 DN(JC,1)
          C
                BYTE LINE1(1),LINE2(1),FRMTI(35),FRMTR(35)
          C
                DATA FRMTI/'(','1','X',',','1','P','E','1','2','.','5',',','1',
               1  'H','*',',','1','0','(','I','1','0',',','1','X',')',')',
               2  8*' '/
          C
                DATA FRMTR/'(','1','X',',','1','P','E','1','2','.','5',',','1',
               1  'H','*',',','1','0','(','0','P','F','1','0','.','1',',',
               2  '1','X',')',')',4*' '/
          C
                LNPRRW=MAXD/10
                IF (MOD(MAXD,10).GT.0)LNPRRW=LNPRRW+1
                PGPRST=MAXC/50
                IF (MOD(MAXC,50).NE.0)PGPRST=PGPRST+1
                NPAGES=LNPRRW*PGPRST
                WRITE(LP,1)
                WRITE(LP,6)(LINE1(NDX),NDX=1,80)
                WRITE(LP,6)(LINE2(NDX),NDX=1,80)
                LIN=0
          C
          C
                IDBEG=1
                KNTC=1
                DO (I=1,NPAGES)
                .  IF (KNTC .EQ. 1)
                .  .  IF (I.GT.1)WRITE(LP,1)
```

```
             .  .  IDEND=IDBEG+9
             .  .  LIN=0
             .  .  IF (IDEND .GT. MAXD)IDEND=MAXD
             .  ...FIN
             .  WRITE(LP,4)
             .  WRITE(LP,2)(D(NDX),NDX=IDBEG,IDEND)
             .  WRITE(LP,3)
             .  UNTIL(LIN.GT.50.OR.KNTC.GT.MAXC)
             .  .  SELECT (TYPIND)
             .  .  .  (1) WRITE(LP,FRMTI)C(KNTC),(N(KNTC,NDX),NDX=IDBEG,IDEND)
             .  .  .  (2) WRITE(LP,FRMTR)C(KNTC),(R(KNTC,NDX),NDX=IDBEG,IDEND)
             .  .  .  (3) WRITE(LP,FRMTI)C(KNTC),(DN(KNTC,NDX),NDX=IDBEG,IDEND)
             .  .  ...FIN
             .  .  KNTC=KNTC+1
             .  .  LIN=LIN+1
             .  ...FIN
        100  .  CONTINUE
             .  IF (KNTC.GT.MAXC)
             .  .  KNTC=1
             .  .  IDBEG=IDBEG+10
             .  ...FIN
             ...FIN
      C
      C     **FORMATS**
      C
        1    FORMAT(1H1/1H0)
        2    FORMAT(/,13X,10(F10.2,1X))
        3    FORMAT(1X,'CONCENTRATION',<IDEND-IDBEG+1>(9('-'),2X))
       4     FORMAT(57X,'DURATION')
        6    FORMAT(21X,80A1)
             RETURN
             END

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              SUBROUTINE NORCUM(X,AMEAN,SIGMA,P)
        C
        C     NORCUM COMPUTES THE CUMULATIVE (-INFINITY, X) PROBABILITY
        C     P FOR THE NORMAL DISTRIBUTION WITH MEAN AMEAN AND STAND-
        C     ARD DEVIATION SIGMA.
        C
        C     PROCEDURE USES A POWER SERIES EXPANSION FOR 0.LE.Z.LE.1
        C     GIVEN BY EQ. 7.1.6 IN ABRAMOWITZ AND STEGUN. FOR Z.GT.1
        C     THE CONTINUED FRACTION EXPANSION IN EQ. 7.1.14 IN
        C     ABRAMOWITZ AND STEGUN IS USED.
        C
        C     PROGRAMED AND CHECKED BY AR(TONY) OLSEN
        C     DATE: OCTOBER 2, 1978
        C
              DATA ERR/1.0E-8/
              Y=(X-AMEAN)/SIGMA
              AY = ABS(Y)/SQRT(2.)
              IF(AY.GT.1.) GO TO 30
              A1 = AY
              A2 = AY
              DO 10 L = 1,50
              A2 = A2*AY*AY/(FLOAT(L)+0.5)
              IF(A2.LT.ERR) GO TO 20
        10    A1 = A1 + A2
        20    ERF = 2.*EXP(-AY*AY)*A1/SQRT(3.1415927)
              GO TO 50
        30    L = INT(12.*AY + 15.)
              A1 = FLOAT(L)/(2.*AY)
              DO 40 I=2,L
              A2 = L-I+1
        40    A1 = (A2/2.)/(AY + A1)
              A1 = AY + A1
              ERF = 1. - EXP(-AY*AY)/A1/SQRT(3.1415927)
        50    S=-1.
              IF(Y.GE.0.0) S = 1.
              P = (1. + S*ERF)/2.
              RETURN
              END

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      SUBROUTINE NORPPF(NOPRAM,PARAM,P,PPF,NAMPRT)
C
C---- NORPPF COMPUTES THE PERCENT POINT FUNCTION (QUANTILE)
C     FOR THE NORMAL DISTRIBUTION WITH MEAN AMEAN AND STANDARD
C     DEVIATION SIGMA GIVEN A PROBABILITY P.  AMEAN AND SIGMA ARE
C     CONTAINED IN PARAM(1) AND PARAM(2) RESPECTIVELY.
C
C---- IF NOPRAM IS ZERO THEN THE DEFAULT VALUES FOR AMEAN AND SIGMA ARE
C     USED,  THAT IS PARAM(1)=0. AND PARAM(2)=1.
C---- IF NAMPRT IS .TRUE. THE ROUTINE WRITES OUT THE DISTRIBUTION
C     NAME, MEAN AND STANDARD DEVIATION.  NO CALCULATIONS OCCURS IN
C     NAME, ALPHA AND BETA.  NO CALCULATIONS OCCURS IN THIS CASE.
C     IF NAMPRT IS .FALSE. NO WRITING OCCURS, BUT THE COMPUTATION
C     IS MADE.
C
C---- PROCEDURE USES A RATIONAL APPROXIMATION GIVEN BY
C     EQ. 26.2.23 IN ABRAMOWITZ AND STEGUN.
C
C---- PROGRAMMED AND CHECKED BY AR(TONY) OLSEN
C              DATE. OCTOBER 2, 1978
C
      LOGICAL NAMPRT
C
      DIMENSION PARAM(NOPRAM)
C
      COMMON /IODEV/IPR,IRD
C
      DATA C0,C1,C2,D1,D2,D3/2.517717,0.802853,0.010328,
     1                       1.432788,0.189269,0.001308/
C
      IF(NOPRAM) 2,1,2
C---- DEFAULT VALUES
    1 AMEAN=0.
      SIGMA=1.
      GO TO 3
    2 AMEAN=PARAM(1)
      SIGMA=PARAM(2)
    3 IF(NAMPRT) GO TO 60
C
      X=0.
      IF(P.LE.0..OR.P.GE.1.0) GO TO 50
      R=P
      IF(P.EQ.0.5) GO TO 40
      IF(P.GT.0.5) R = 1.-R
      T=SQRT(-2.*ALOG(R))
      ANUM=C0+T*(C1+T* C2)
      ADEN=1.+T*(D1+T*(D2+T*D3))
      X=T-ANUM/ADEN
      IF(P.LT.0.5) X=-X
   40 PPF=X*SIGMA+AMEAN
      RETURN
C
   50 PPF=0.
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              RETURN
        C
        C---- WRITE TITLE AND RETURN
        60    WRITE(IPR,1000) AMEAN,SIGMA
        1000  FORMAT(20X,'EXPECTED NORMAL WITH MEAN=',1PE15.7,
             1 14H AND STD DEV =E15.7)
              RETURN
              END

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              SUBROUTINE OPT1(LMT,ARAY,DORC,NVALS,IER)
      C
      C   THIS PROGRAM IS CALLED BY FACINP WHEN EITHER OPTC OR OPTD
      C   IS INPUT AS '1' TO EXPLICITLY READ THE SPECIFIED CONCENTRATION
      C   OR DURATION VALUES.
      C
      C      LMT   = MAXIMUM NUMBER OF VALUES THAT CAN BE READ
      C      ARAY  = HOLDING ARRAY FOR THE VALUES READ
      C      DORC  = 'C'; CONCENTRATION VALUES BEING PROCESSED
      C              'D'; DURATION VALUES BEING PROCESSED
      C      NVALS = NUMBER OF VALUES THAT WERE READ
      C      IER   = DATA ERROR FLAG
      C
             INCLUDE 'SY:FRANCO.PRM'
             BYTE DORC
      C
             DIMENSION ARAY(1)
      C
             READ(1,1) NVALS
             SELECT (DORC)
             .  ('C') WRITE(LP,2) NVALS
             .  ('D') WRITE(LP,3) NVALS
             ...FIN
             WHEN (NVALS .GT. LMT)
             .  IER=2
             .  WRITE(LP,4) LMT
             ...FIN
             ELSE
             .  IER=0
             .  SELECT (DORC)
             .  .  ('C') WRITE(LP,5)
             .  .  ('D') WRITE(LP,6)
             .  ...FIN
             .  READ(1,7) (ARAY(I),I=1,NVALS)
             .  WRITE(LP,8) (ARAY(I),I=1,NVALS)
             ...FIN
             RETURN
      C
      1      FORMAT(I5)
      2      FORMAT(1H0,15X,I5,' NUMBER OF SPECIFIED CONCENTRATIONS TO BE'
            1 ' READ')
      3      FORMAT(1H0,15X,I5,' NUMBER OF SPECIFIED DURATIONS TO BE READ')
      4      FORMAT(1H0,49X,'***** FATAL ERROR *****'/
            1 38X,'THE MAXIMUM OF',I5,' SPECIFIED CONDITIONS EXCEEDED'/
            2 46X,'SCANNING WAS SUSPENDED')
      5      FORMAT(1H0,52X,'SPECIFIED CONCENTRATIONS')
      6      FORMAT(1H0,55X,'SPECIFIED DURATIONS')
      7      FORMAT(8F10.0)
      8      FORMAT(1X,1P10E13.5)
      C
             END

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              SUBROUTINE OPT2(LMT,ARAY,DORC,NVALS,IER)
        C
        C   THIS ROUTINE IS CALLED BY FACINP WHEN EITHER OPTC OR OPTD IS
        C   INPUT AS "2", A LOWER BOUND, UPPER BOUND AND INCREMENT ARE READ
        C   AND FROM THIS THE NUMBER OF VALUES AND THE VALUES ARE DETERMINED.
        C
        C      LMT   - MAXIMUM NUMBER OF VALUES THAT CAN BE CALCULATED
        C      ARAY  - HOLDING ARRAY FOR THE CALCULATED VALUES
        C      DORC  = "C"; CONCENTRATIONS BEING PROCESSED
        C              "D"; DURATIONS BEING PROCESSED
        C      NVALS - NUMBER OF VALUES THAT ARE COMPUTED
        C      IER   - DATA ERROR FLAG
        C
              INCLUDE 'SY:FRANCO.PRM'
              BYTE DORC
        C
              DIMENSION ARAY(1)
        C
              READ(1,1) VMIN,VMAX,VINTVL
              NVALS=(VMAX-VMIN)/VINTVL+1
              SELECT (DORC)
              .  ('C') WRITE(LP,2)
              .  ('D') WRITE(LP,3)
              ...FIN
              WRITE(LP,4) VMIN,VMAX,VINTVL,NVALS
              WHEN (NVALS .GT. LMT)
              .  IER=1
              .  WRITE(LP,5) LMT
              ...FIN
              ELSE
              .  IER=0
              .  ARAY(1)=VMIN
              .  DO (I=2,NVALS)
              .  .  ARAY(I)=ARAY(I-1)+VINTVL
              .  ...FIN
              .  SELECT (DORC)
              .  .  ('C') WRITE(LP,7)
              .  .  ('D') WRITE(LP,8)
              .  ...FIN
              .  WRITE(LP,6) (ARAY(I),I=1,NVALS)
              ...FIN
              RETURN
        C
        1     FORMAT(3F10.0)
        2     FORMAT(1H0,9X,'THE SECOND METHOD HAS BEEN CHOOSEN FOR INPUTTING'
             1 ' CONCENTRATIONS')
        3     FORMAT(1H0,9X,'THE SECOND METHOD HAS BEEN CHOOSEN FOR INPUTTING'
             1 ' DURATIONS')
        4     FORMAT(9X,1PE12.5,' MINIMUM VALUE'/
             1 9X,1PE12.5,' MAXIMUM VALUE'/
             2 9X,1PE12.5,' INTERVAL BETWEEN VALUES'/
             3 16X,I5,' NUMBER OF VALUES (COMPUTED)')
        5     FORMAT(1H0,99X,'***** FATAL ERROR *****'/
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              1 50X,'THE MAXIMUM OF',I5,' SPECIFIED CONDITIONS EXCEEDED'/
              2 101X,'SCANNING WAS CONTINUED')
         6     FORMAT(1X,1P10E13.5)
         7     FORMAT(1H0,47X,'SPECIFIED CONCENTRATIONS (CALCULATED)')
         8     FORMAT(1H0,49X,'SPECIFIED DURATIONS (CALCULATED)')
         C
               END

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              SUBROUTINE OPT3(LMT,ARAY,DORC,NVALS,IER)
        C
        C   THIS ROUTINE IS CALLED BY FACINP WHEN EITHER OPTC OR OPTD IS INPUT
        C   AS A "3", WITH THIS OPTION, THE USER SPECIFIES A SET OF RANGES AND
        C   THE NUMBER OF VALUES TO BE COMPUTED WITHIN THE RANGE.
        C
        C      LMT   = MAXIMUM NUMBER OF VAUES THAT CAN BE COMPUTED
        C      ARAY  = HOLDING ARRAY FOR THE CALCULATED VALUES
        C      DORC  = ="C"; CONCENTRATIONS BEING PROCESSED
        C              ="D"; DURATIONS BEING PROCESSED
        C      NVALS = NUMBER OF VALUES THAT ARE PLACED INTO ARAY
        C      IER   = DATA ERROR FLAG
        C
              INCLUDE 'SY:FRANCO.PRM'
              BYTE DORC
        C
              DIMENSION ARAY(1),NS(19),VALS(20)
        C
        C     *** EXPLANATION OF INPUT VALUES ***
        C          NSETS   = NUMBER OF RANGES TO BE READ
        C          VALS(I) = LOWER LIMIT OF RANGE I+1; UPPER LIMIT OF RANGE I
        C                    VALS(1) IS THE MINIMUM VALUE
        C                    VALS(NSET+1) IS THE MAXIMUM VALUE
        C          NS(I)   = NUMBER OF VALUES TO BE COMPUTED BETWEEN VALS(I)
        C                    AND VALS(I+1)
        C
              READ(1,1) NSETS,VALS(1)
              READ(1,1) (NS(I),VALS(I+1),I=1,NSETS)
              SELECT (DORC)
              .  ('C') WRITE(LP,2)
              .  ('D') WRITE(LP,3)
              ...FIN
        C
        C     *** DETERMINE THE TOTAL NUMBER OF VALUES ***
              NVALS = 1
              DO (I=1,NSETS) NVALS = NVALS + NS(I) + 1
              WRITE(LP,4) VALS(1),(NS(I),I,VALS(I+1),I,I=1,NSETS)
              WRITE(LP,8) NVALS
              WHEN (NVALS .GT. LMT)
              .  IER=1
              .  WRITE(LP,5) LMT
              ...FIN
              ELSE
              .  IER=0
              .  KVALS=0
              .  DO (I=2,NSETS+1)
        C     .  .
        C     .  .  *** PLACE LOWER LIMIT INTO HOLDING ARRAY ***
              .  .  KVALS=KVALS+1
              .  .  ARAY(KVALS)=VALS(I-1)
              .  .  N = NS(I-1)
              .  .  IF (N .NE. 0)
        C     .  .  .  *** COMPUTE INTERIM VALUES BETWEEN VALS(I-1) AND VALS(I) ***
```

```
              .  .  .  SELECT (DORC)
              .  .  .  .  ('D')
              .  .  .  .  .  RINT=(VALS(I)-VALS(I-1))/(N+1)
              .  .  .  .  .  DO (K=1,N)
              .  .  .  .  .  .  KVALS=KVALS + 1
              .  .  .  .  .  .  ARAY(KVALS)=ARAY(KVALS-1) + RINT
              .  .  .  .  .  ...FIN
              .  .  .  .  ...FIN
              .  .  .  .  ('C')
              .  .  .  .  .  RINT = (ALOG(VALS(I))-ALOG(VALS(I-1))) / (N+1)
              .  .  .  .  .  DO (K=1,N)
              .  .  .  .  .  .  KVALS = KVALS + 1
              .  .  .  .  .  .  TMP = ALOG(ARAY(KVALS-1)) + RINT
              .  .  .  .  .  .  ARAY(KVALS) = EXP(TMP)
              .  .  .  .  .  ...FIN
              .  .  .  .  ...FIN
              .  .  .  ...FIN
              .  .  ...FIN
              .  ...FIN
C             .
C             .  *** PLACE MAXIMUM VALUE INTO HOLDING ARRAY ***
              .  ARAY(NVALS)=VALS(NSETS+1)
              .  SELECT (DORC)
              .  .  ('C') WRITE(LP,6)
              .  .  ('D') WRITE(LP,9)
              .  ...FIN
              .  WRITE(LP,7) (ARAY(I),I=1,NVALS)
              ...FIN
              RETURN
C
1             FORMAT(I5,F10.0)
2             FORMAT(1H0,9X,'THE THIRD METHOD HAS BEEN CHOOSEN FOR INPUTTING',
             1 ' CONCENTRATIONS')
3             FORMAT(1H0,9X,'THE THIRD METHOD HAS BEEN CHOOSEN FOR INPUTTING',
             1 ' DURATIONS')
4             FORMAT(1H0,8X,1PE12.5,' LIMIT FOR RANGE 1'/
             1 (16X,I5,' NUMBER OF INTERIM VALUES IN RANGE',I2/
             2    9X,1PE12.5,' LIMIT FOR RANGE',I2/))
5             FORMAT(1H0,99X,'***** FATAL ERROR *****'/
             1 50X,'THE MAXIMUM OF',I5,' SPECIFIED CONDITIONS EXCEEDED'/
             2 101X,'SCANNING HAS CONTINUED')
6             FORMAT(1H0,47X,'SPECIFIED CONCENTRATIONS (CALCULATED)')
7             FORMAT(1X,1P10E13.5)
8             FORMAT(16X,I5,' NUMPER OF VALUES (COMPUTED)')
9             FORMAT(1H0,49X,'SPECIFIED DURATIONS (CALCULATED)')
C
              END

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              SUBROUTINE PIECE(CF,DF,NLC,NPT,A,B)
        C
        C   THE PURPOSE OF THIS POUTINE IS TO CONSTRUCT NLC PIECEWISE
        C   LINEAR FUNCTIONS C=F(D) FROM AN INPUT OF NPT PAIRS OF POINTS
        C   (DF(I,J),CF(I,J)) FOR EACH FUNCTION. A(I,J) AND B(I,J) OF A LINE
        C   SEGMENT WITH AN INFINITE SLOPE ARE RETURNED AS 0.
        C
        C       CF(I,J) = CONCENTRATION VALUE FOR FUNCTION I, POINT J
        C       DF(I,J) = TIME FOR FUNCTION I, POINT J
        C       NLC     = NUMBER OF LC PIECEWISE LINEAR FUNCTIONS
        C       NPT     = NUMBER OF PAIRS USED TO DESCRIBE FUNCTIONS
        C       A(I,J)  = INTERCEPT OF FUNCTION I, LINE SEGMENT J
        C       B(I,J)  = SLOPE OF FUNCTION I, LINE SEGMENT J
        C
              INCLUDE 'SY:FRANCO.PRM'
              DIMENSION CF(NLCF,NLCP),DF(NLCF,NLCP),A(NLCF,NLCP),B(NLCF,NLCP)
        C
              DO (I=1,NLC)
              .  DO (J=1,NPT-1)
              .  .  WHEN(DF(I,J) .EQ. DF(I,J+1))
              .  .  .  A(I,J)=0.
              .  .  .  B(I,J)=0.
              .  .  ...FIN
              .  .  ELSE
              .  .  .  B(I,J)=(CF(I,J+1)-CF(I,J))/(DF(I,J+1)-DF(I,J))
              .  .  .  A(I,J)=CF(I,J)-B(I,J)*DF(I,J)
              .  .  ...FIN
              .  ...FIN
              ...FIN
              RETURN
              END

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              SUBROUTINE PLTSUM(C,NT,NC,NTIM,AMEAN,LMEAN,ASD,LSD,ALPHA,BETA)
        C
              EXTERNAL NORPPF,GAMPPF
        C
              INCLUDE 'SY:FRANCO.PRM'
        C
              INTEGER*4 NT(JC,JD),NCI(JC),NTIM
        C
              REAL LSD(2),LMEAN(2)
        C
              DIMENSION C(JC),PNCI(JC),IDUM(JC),DUM(JC),
             1          PARAM(2),WORK(3*JC),AMEAN(2),ASD(2)
        C
              COMMON /SCALE/ UYMIN,UYMAX,UXMIN,UXMAX
              COMMON /CONTRL/ LI,NCOL,IXAX,IYAX,ICONZ,NDIGIT,FORM
              COMMON /IODEV/ IPR,IRD
        C
        C     *** FREQUENCE PLOT ***
              DO (I=3,NC)
              .  NCI(I-2) = NT(2,1) - NT(I,1)
              .  PNCI(I-2) = FLOAT(NCI(I-2)) / FLOAT(NT(2,1))
              .  WORK(I-2) = ALOG10(C(I))
              ...FIN
              NCPLOT = NC + 1
              REPEAT UNTIL (NT(NCPLOT,1) .NE. 0) NCPLOT = NCPLOT - 1
              FORM = 'E9.2'
              IPR = LP
              IYAX = 4
              UYMIN = 0.0
              UYMAX = 1.0
              WRITE(LP,1)
        1     FORMAT(1H1,34X,'LOG 10 CONCENTRATION (X) VS CUMULATIVE '
             1 'FREQUENCY (Y)')
              CALL CROSS(NCPLOT-2,WORK,PNCI,'*',IDUM,DUM,0)
        C
        C     *** NORMAL PLOT ***
              IYAX = 2
              PARAM(1) = AMEAN(2)
              PARAM(2) = ASD(2)
              WRITE(LP,2)
        2     FORMAT(1H1,49X,'NORMAL PROBABILITY PLOT'/
             1 36X,'OBSERVED CONCENTRATION (X) VS NORMAL QUANTILE (Y)')
              CALL QQPLOT(NCPLOT-2,C(3),.FALSE.,2,PARAM,NORPPF,DUM,
             1          WORK,NCI,NT(2,1))
        C
        C     *** LOG NORMAL PLOT ***
              PARAM(1) = LMEAN(2)
              PARAM(2) = LSD(2)
              WRITE(LP,3)
        3     FORMAT(1H1,47X,'LOG NORMAL PROBABILITY PLOT'/
             34X,'LOG OBSERVED CONCENTRATION (X) VS NORMAL QUANTILE (Y)')
              CALL QQPLOT(NCPLOT-2,C(3),.TRUE.,2,PARAM,NORPPF,DUM,
             1          WORK,NCI,NT(2,1))
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      C
      C      *** GAMMA PLOT ***
             PARAM(1) = ALPHA
             PARAM(2) = BETA
             WRITE(LP,4)
      4      FORMAT(1H1,49X,'GAMMA PROBABILITY PLOT'/
            1 36X,'OBSERVED CONCENTRATION (X) VS GAMMA QUANTILE (Y)')
             CALL QQPLOT(NCPLOT-2,C(3),.FALSE.,2,PARAM,GAMPPF,DUM,
            1            WORK,NCI,NT(2,1))
             RETURN
             END

      (FLECS VERSION 22.46)

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                SUBROUTINE PSCALE(IAXIS,ISCALE,LINBEG,SMIN,SMAX,SINCR,SFIRST,
               1                    LINENO)
        C
                IF (ISCALE) 5,5,10
        5       SFIRST=SMAX
                IF(IAXIS .EQ. 2) SFIRST=SMIN
                SINCR=(SMAX-SMIN)/FLOAT(LINBEG)
                LINEND=LINBEG+1
                RETURN
        10      M=LINBEG/IAXIS
        15      SLOG=ALOG10((SMAX-SMIN)/FLOAT(M))
                SINCR=AINT(10.**(AMOD(SLOG+40.,1.)+FLOAT(ISCALE)-1.)+0.5)
                SINCR=SINCR*10.**(INT(SLOG+40.)-39-ISCALE)
                TENS=10.0*SINCR
                MAXS=(SMAX/TENS)+(0.5+SIGN(0.5,SMAX))
                MINS=(SMIN/TENS)-(0.5+SIGN(0.5,-SMIN))
                LINEND=10*(MAXS-MINS)*IAXIS
                IF(LINEND .LE. LINBEG) GO TO 20
                M=M-5
                GO TO 15
        20      LINEND=LINEND+1
                GO TO (21,22) IAXIS
        21      SFIRST=TENS*FLOAT(MAXS)
                RETURN
        22      SINCR=SINCR/2.
                SFIRST=TENS*FLOAT(MINS)
                RETURN
                END

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              SUBROUTINE QQPLOT(N,X,LOGX,NOPRAM,PARAM,PPF,XS,WORK,NCI,NFREQ)
        C
        C---- THIS SUBROUTINE MAKES A LINE-PRINTER PLOT OF THE DATA IN THE
        C     ARRAY X(.) VS PERCENT POINT PROBABILITY DATA (QUANTILES) OBTAINED
        C     FROM THE SUBPROGRAM PPF.
        C
        C---- INPUT ARGUMENTS
        C     N      - NO. OF DATA POINTS IN THE ARRAY X(.).
        C     X      - ARRAY CONTAINING THE DATA TO BE PLOTTED ON THE X-AXIS.
        C              SEE ALSO LOGX BELOW.  DIMENSION .GE. N.
        C     LOGX   - A LOGICAL VARIABLE
        C              IF LOGX=.TRUE.  THEN ALOG(X(.)) IS PLOTTED ON THE X-AXIS
        C              IF LOGX=.FALSE. THEN      X(.)  IS PLOTTED ON THE X-AXIS.
        C     NOPRAM - NO. OF PARAMETERS REQUIRED BY PPF.
        C     PARAM  - ARRAY CONTAINING THE PARAMETERS REQUIRED BY PPF.
        C              DIMENSION .GE. NOPRAM.
        C     PPF    - SUBROUTINE SUBPROGRAM TO COMPUTE THE PERCENT POINT
        C              PROBABILITY DATA (QUANTILES) TO BE PLOTTED ON THE
        C              X-AXIS.
        C     XS     - A SCRATCH ARRAY WHICH AFTER THE RETURN, WILL CONTAIN
        C              THE ARRAY X(.) (OR ALOG(X(.))) AFTER SORTING SUCH THAT
        C              XS(1) .LE. XS(2) .LE. ... .LE. XS(N).
        C              DIMENSION .GE. N.
        C     WORK   - A SCRATCH ARRAY.  DIMENSION .GE. 3*N.
        C
        C---- IN ADDITION TO PPF, THIS ROUTINE REQUIRES THE FOLLOWING
        C     SUBPROGRAMS.  CROSS,SORTP,UNIFRQ
        C
              LOGICAL LOGX
        C
              INTEGER*4 NCI(1),NFREQ
        C
              DIMENSION X(1),XS(1),WORK(3),PARAM(1)
        C
              COMMON/IODEV/IPR,IRD
        C
        C
              CALL SORTP(X,N,XS,WORK)
              CALL UNIFRQ(N,NCI,WORK,NFREQ)
              IF(.NOT.LOGX) GO TO 20
              DO 10 I=1,N
           10 XS(I)=ALOG(XS(I))
        C
           20 DO 30 I=1,N
              CALL PPF(NOPRAM,PARAM,WORK(I),PPFVAL,.FALSE.)
              J=I+N
              WORK(J)=PPFVAL
           30 CONTINUE
        C
              IF(.NOT. LOGX) WRITE (IPR,1000)
         1000 FORMAT(45H QQPLOT   X-AXIS ORDERED DATA   VS   Y-AXIS -)
              IF(LOGX) WRITE (IPR,2000)
         2000 FORMAT(50H QQPLOT   X-AXIS LOG(ORDERED DATA)   VS   Y-AXIS -)
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      C
      C---- MAKE PRINT CALL
            CALL PPF(NOPRAM,PARAM,WORK,PPFVAL,,TRUE,)
      C---- DRAW PLOT
            CALL CROSS(N,XS,WORK(N+1),'*',WORK(1),WORK(2*N+1),0)
            RETURN
            END

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      SUBROUTINE SORTP(X,N,Y,IPOS)
C     THIS ROUTINE SORTS THE ELEMENTS OF THE INPUT VECTOR X AND PUTS THE
C     SORTED ELEMENTS INTO THE VECTOR Y.  IT ALSO CARRIES ALONG THE
C     INDEX NUMBER OF EACH ORDERED OBSERVATION-- THAT IS, IT CARRIES ALO
C     THE POSITION OF THE I-TH ORDERED OBSERVATION (FOR EACH I) AS IT
C     WAS IN THE ORIGINAL UNORDERED DATA VECTOR X.  THESE POSITIONS ARE
C     PLACED IN THE VECTOR IPOS.  THIS ROUTINE IS USEFUL IN ATTEMPTING T
C     LOCATE THE MINIMUM, THE MAXIMUM, OR SOME OTHER ORDERED OBSERVATION
C     OF INTEREST IN THE ORIGINAL UNORDERED INPUT VECTOR X.
C     THE INPUT TO THIS ROUTINE IS THE SINGLE PRECISION VECTOR X OF
C     (UNSORTED) OBSERVATIONS, THE INTEGER VALUE N (= SAMPLE SIZE),
C     AN EMPTY SINGLE PRECISION VECTOR Y INTO WHICH THE SORTED OBSERVATI
C     WILL BE PLACED, AND AN EMPTY SINGLE PRECISION VECTOR IPOS INTO WHI
C     POSITIONS OF THE SORTED OBSERVATIONS WILL BE PLACED.
C     THE OUTPUT FROM THIS ROUTINE IS THE SINGLE PRECISION VECTOR Y INTO
C     THE SORTED OBSERVATIONS HAVE BEEN PLACED, AND THE SINGLE PRECISION
C     IPOS INTO WHICH THE POSITIONS OF THE SORTED OBSERVATIONS HAVE BEEN
C     RESTRICTIONS ON THE MAXIMUM ALLOWABLE VALUE OF N--THE DIMENSIONS
C     OF VECTORS IU AND IL (DEFINED AND USED INTERNALLY WITHIN THIS ROUT
C     DETERMINE THE MAXIMUM ALLOWABLE VALUE OF N FOR THIS
C     ROUTINE.  IF IU AND IL EACH HAVE DIMENSION K, THEN N MAY NOT EXCEE
C     2**(K+1) - 1.  FOR THIS ROUTINE AS WRITTEN, THE DIMENSIONS OF IU A
C     HAVE BEEN SET TO 36, THUS THE MAXIMUM ALLOWABLE VALUE OF N IS
C     APPROXIMATELY 137 BILLION.  SINCE THIS EXCEEDS THE MAXIMUM ALLOWAB
C     VALUE FOR AN INTEGER VARIABLE IN MANY COMPUTERS, AND SINCE A SORT
C     BILLION ELEMENTS IS PRESENTLY IMPRACTICAL AND UNLIKELY, THEREFORE
C     TEST FOR WHETHER THE INPUT SAMPLE SIZE N EXCEEDS 137 BILLION HAS B
C     INCORPORATED INTO THIS ROUTINE.  IT IS THUS ASSUMED THAT THERE IS
C     (PRACTICAL) RESTRICTION ON THE MAXIMUM VALUE OF N FOR THIS ROUTINE
C     PRINTING--NONE UNLESS AN ERROR CONDITION EXISTS
C     THIS ROUTINE IS SINGLE PRECISION IN INTERNAL OPERATION.
C     SUBROUTINES NEEDED--NONE
C     SORTING METHOD--BINARY SORT
C     REFERENCE--CACM MARCH 1969, PAGE 186 (BINARY SORT ALGORITHM BY RIC
C                    C. SINGLETON.
C                 --CACM JANUARY 1970, PAGE 54.
C                 --CACM OCTOBER 1970, PAGE 624.
C                 --JACM JANUARY 1961, PAGE 41.
C     WRITTEN BY JAMES J. FILLIBEN, STATISTICAL ENGINEERING LABORATORY
C     NATIONAL BUREAU OF STANDARDS, WASHINGTON, D.C. 20234       JUNE 19
      DIMENSION X(N),Y(N),IPOS(N)
      COMMON /IODEV/ IPR,IRD
      DIMENSION IU(36),IL(36)
C     CHECK THE INPUT ARGUMENTS FOR ERRORS
      IF(N.LT.1)GOTO50
      IF(N.EQ.1)GOTO55
      HOLD=X(1)
      DO60I=2,N
      IF(X(I).NE.HOLD)GOTO90
   60 CONTINUE
C     WRITE (IPR,9)  HOLD
      DO61I=1,N
      Y(I)=X(I)
      IPOS(I)=I
   61 CONTINUE
      RETURN
   50 WRITE(IPR,15)
      WRITE(IPR,47)N
      RETURN
   55 WRITE(IPR,18)
      Y(1)=X(1)
      IPOS(1)=1.0
      RETURN
   90 CONTINUE
    9 FORMAT(1H ,100H***** NON-FATAL DIAGNOSTIC--THE FIRST  INPUT ARGUME
     1NT (A VECTOR) TO THE SORTP  SUBROUTINE HAS ALL ELEMENTS = ,E15.8,6
     1H *****)
   15 FORMAT(1H , 91H***** FATAL ERROR--THE SECOND INPUT ARGUMENT TO THE
     1 SORTP  SUBROUTINE IS NON-POSITIVE *****)
   18 FORMAT(1H ,100H***** NON-FATAL DIAGNOSTIC--THE SECOND INPUT ARGUME
     1NT TO THE SORTP  SUBROUTINE HAS THE VALUE 1 *****)
   47 FORMAT(1H ,35H***** THE VALUE OF THE ARGUMENT IS ,I8,6H *****)
C
C     COPY THE VECTOR X INTO THE VECTOR Y
      DO100I=1,N
      Y(I)=X(I)
  100 CONTINUE
C
C     DEFINE THE IPOS (POSITION) VECTOR.  BEFORE SORTING, THIS WILL
C     BE A VECTOR WHOSE I-TH ELEMENT IS EQUAL TO I.
C
      DO150I=1,N
      IPOS(I)=I
  150 CONTINUE
C
C     CHECK TO SEE IF THE INPUT VECTOR IS ALREADY SORTED
C
      NM1=N-1
      DO200I=1,NM1
      IP1=I+1
      IF(Y(I).LE.Y(IP1))GOTO200
      GOTO250
  200 CONTINUE
      RETURN
  250 M=1
      I=1
      J=N
  305 IF(I.GE.J)GOTO370
  310 K=I
      MID=(I+J)/2
      AMED=Y(MID)
      IMED=IPOS(MID)
      IF(Y(I).LE.AMED)GOTO320
      Y(MID)=Y(I)
      IPOS(MID)=IPOS(I)
      Y(I)=AMED
      IPOS(I)=IMED
      AMED=Y(MID)
      IMED=IPOS(MID)
```

```
320 L=J
    IF(Y(J).GE.AMED)GOTO340
    Y(MID)=Y(J)
    IPOS(MID)=IPOS(J)
    Y(J)=AMED
    IPOS(J)=IMED
    AMED=Y(MID)
    IMED=IPOS(MID)
    IF(Y(I).LE.AMED)GOTO340
    Y(MID)=Y(I)
    IPOS(MID)=IPOS(I)
    Y(I)=AMED
    IPOS(I)=IMED
    AMED=Y(MID)
    IMED=IPOS(MID)
    GOTO340
330 Y(L)=Y(K)
    IPOS(L)=IPOS(K)
    Y(K)=TT
    IPOS(K)=ITT
340 L=L-1
    IF(Y(L).GT.AMED)GOTO340
    TT=Y(L)
    ITT=IPOS(L)
350 K=K+1
    IF(Y(K).LT.AMED)GOTO350
    IF(K.LE.L)GOTO330
    LMI=L-I
    JMK=J-K
    IF(LMI.LE.JMK)GOTO360
    IL(M)=I
    IU(M)=L
    I=K
    M=M+1
    GOTO380
360 IL(M)=K
    IU(M)=J
    J=L
    M=M+1
    GOTO380
370 M=M-1
    IF(M.EQ.0)RETURN
    I=IL(M)
    J=IU(M)
380 JMI=J-I
    IF(JMI.GE.11)GOTO310
    IF(I.EQ.1)GOTO395
    I=I-1
390 I=I+1
    IF(I.EQ.J)GOTO370
    AMED=Y(I+1)
    IMED=IPOS(I+1)
    IF(Y(I).LE.AMED)GOTO390
    K=I
395 Y(K+1)=Y(K)
    IPOS(K+1)=IPOS(K)
```

```
              K=K-1
              IF(AMED.LT.Y(K))GOTO395
              Y(K+1)=AMED
              IPOS(K+1)=IMED
              GOTO398
              END

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                SUBROUTINE SUMSAT(AMEAN, ASUMS, CONC, LMEAN, LSUMS, W)
          C
          C   THIS SUBROUTINE IS RESPONSIBLE FOR ACCUMULATING THE PARTIAL VALUES
          C   THAT WILL FORM THE SUMMARY STATISTICS.
          C
          C   FORMAL PARAMETERS:
          C      AMEAN  - ARITHMETIC MEAN
          C      ASUMS  -
          C      CONC   - CONCENTRATION
          C      LMEAN  - LOG MEAN
          C      LSUMS  -
          C      W      - COUNT OF THE NUMBER OF SUMS IN AMEAN (W(I,1)) AND
          C               LMEAN (W(I,2))
          C      SUBSCRIPT 1 = ALL CONCENTRATION VALUES
          C                2 = ONLY NONZERO CONCENTRATION VALUES
          C
          C   CALLED BY: FRANCO
          C
                REAL*4 LMEAN(2), LSUMS(2)
          C
                DIMENSION AMEAN(2), ASUMS(2), W(2,2)
          C
                I = 1
                COMPUTE-VALUES
                IF (CONC .GT. 0.0)
                .  I = 2
                .  COMPUTE-VALUES
                ...FIN
                RETURN
          C

          ----------------------------------------

                TO COMPUTE-VALUES
                .  DEV = CONC - AMEAN(I)
                .  W(I,1) = W(I,1) + 1.0
                .  AMEAN(I) = AMEAN(I) + DEV / W(I,1)
                .  ASUMS(I) = ASUMS(I) + DEV * (CONC - AMEAN(I))
                .  IF (CONC .GT. 0.0)
                .  .  W(I,2) = W(I,2) + 1.0
                .  .  CL = ALOG(CONC)
                .  .  DEV = CL - LMEAN(I)
                .  .  LMEAN(I) = LMEAN(I) + DEV / W(I,2)
                .  .  LSUMS(I) = LSUMS(I) + DEV * (CL - LMEAN(I))
                .  ...FIN
                ...FIN
          C
                END

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                PROCEDURE CROSS-REFERENCE TABLE
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           SUBROUTINE UNIFRQ(N,NCI,X,NFREQ)
     C
           INTEGER*4 NCI(1),NFREQ
     C
           DIMENSION X(N)
     C
           DATA GAMMA /0.3/
     C
           DEN = FLOAT(NFREQ+1) - 2.*GAMMA
           DO (I=1,N)
           .  X(I) = (FLOAT(NCI(I)) - GAMMA) / DEN
           ...FIN
           RETURN
           END

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          ---------------------------------------
      C     [101,5] FRANCO.PRM
      C
      C   JC = MAXIMUM NUMBER OF SPECIFIED CONCENTRATIONS
      C   JD = MAXIMUM NUMBER OF SPECIFIED DURATIONS
      C   LP = LINE PRINTER LOGICAL UNIT NUMBER
      C   NLCF = MAXIMUM NUMBER OF LC-50 CURVES
      C   NLCP = MAXIMUM NUMBER OF POINTS IN EACH LC-50 CURVE
      C               *** NOTE ***
      C          IF NLCF IS LARGER THAN 5, LUN AND ITS ASSOCITIATED FILES
      C          WILL HAVE TO BE ALTERED, IF NLCP GOES BEYOND 6, MANY OUTPUT
      C          FORMAT CHANGES WILL HAVE TO BE MADE,
      C
            PARAMETER JC=50, JD=25, JCJD=1250, LP=7, NLCF=5, NLCP=6
```

☆ U.S. GOVERNMENT PRINTING OFFICE: 1980 -559-092/0470